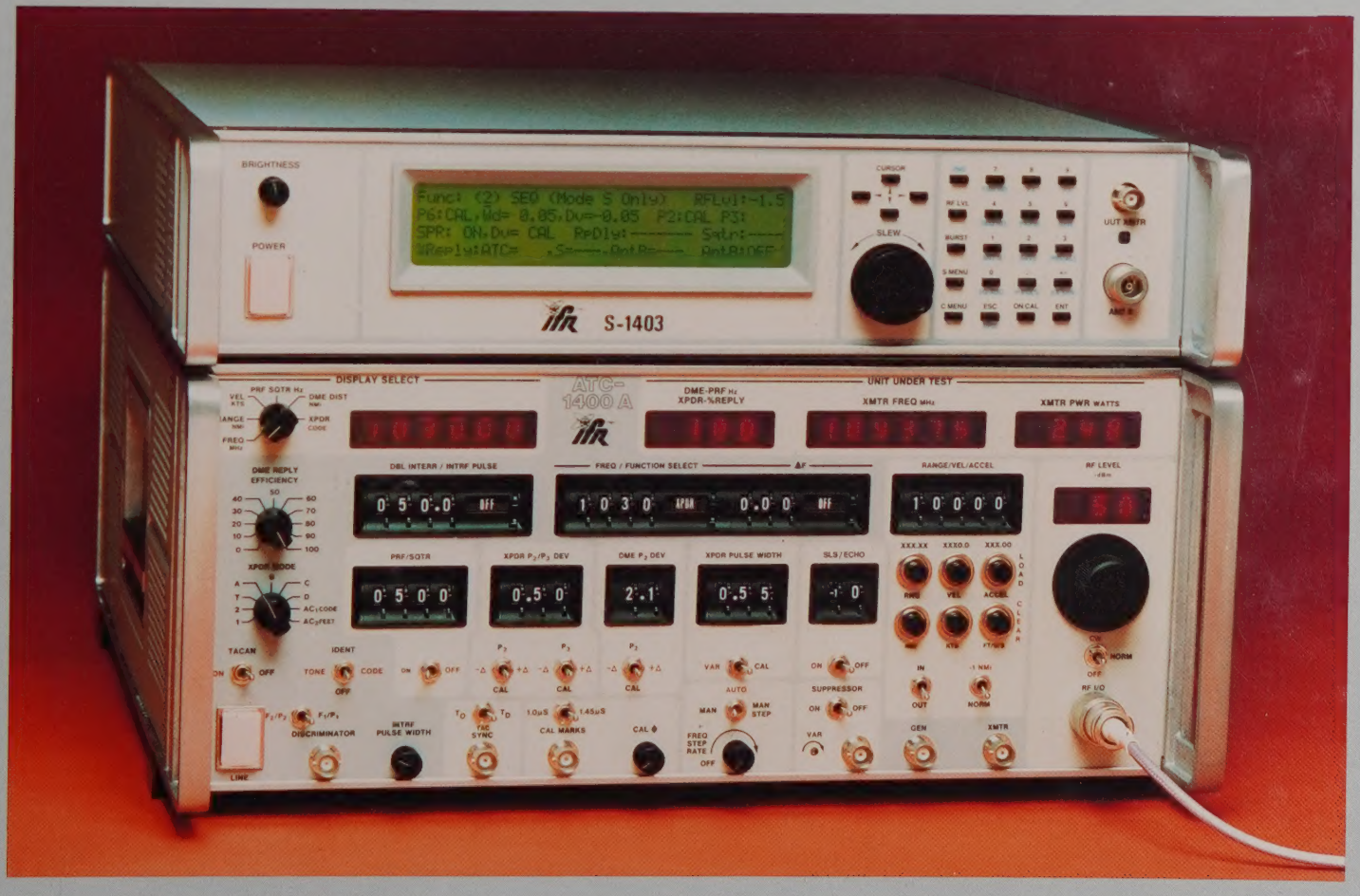
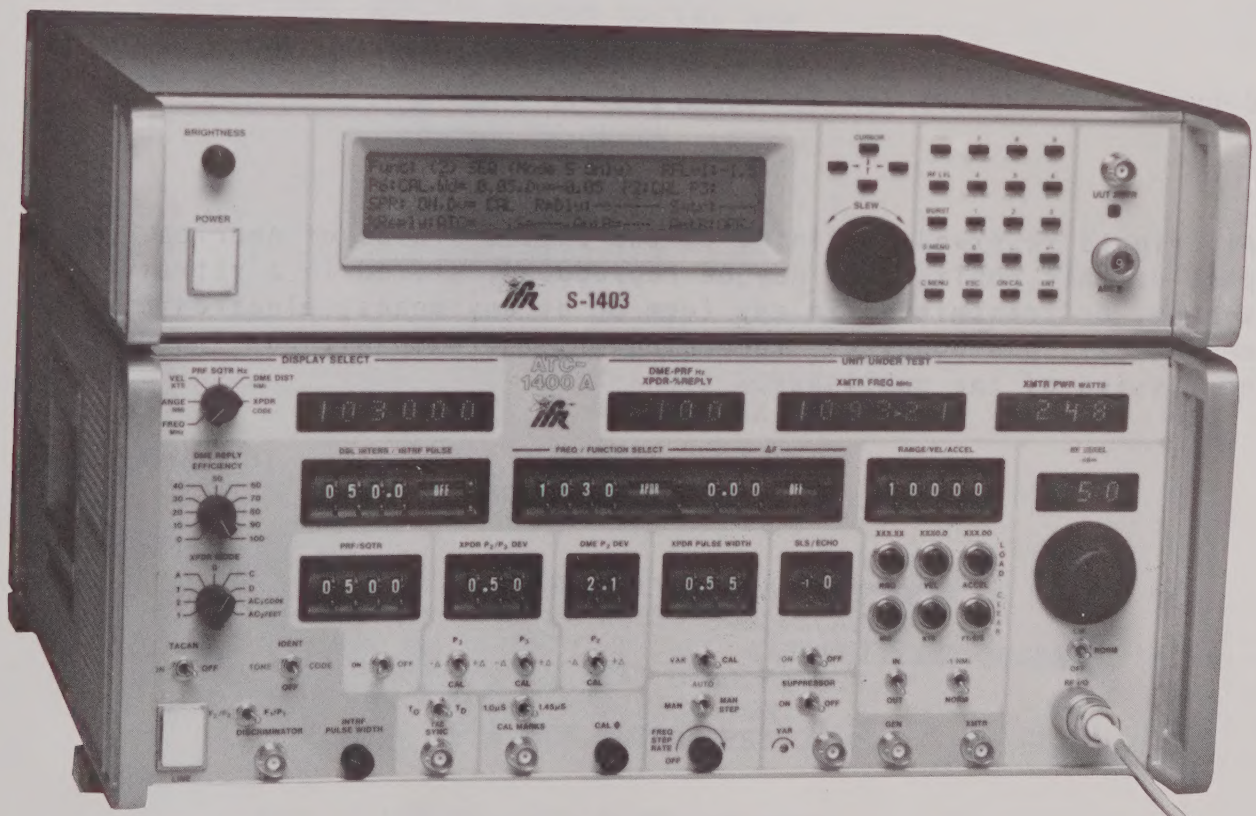
OPERATION MANUAL

MODE S TEST SYSTEM



OPERATION MANUAL

MODE S TEST SYSTEM



10200 West Street/Wichita,Ks 67215 U.S.A./(316) 522-4981/TWX 910-741-6952

1002-6801-000

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IFR SYSTEMS, INC.

PRODUCT INFORMATION / SERVICE BULLETINS

AVIONICS

		RELEASE
ATC-600A		
1. SB-01:	DME CHANNEL PULSE SPACING.	1/90
ATC-601		
1. IB-01:	FIRMWARE VER 1.02 SELF TEST ERROR	11/90
ATC-1400A		
1. SB-01:	FIRMWARE UP-GRADE (VER 2.7)	2/88
2. SB-02:	FIRMWARE UP-GRADE (VER 4.01)	4/90
3. SB-03:	FIRMWARE UP-GRADE (VER 4.02)	8/90
T-1401		
1. SB-01:	LINE FUSE REPLACEMENT.	10/88
I-1402		
1. SB-01:	LINE FUSE REPLACEMENT.	10/88
2. SB-02:	MODE-4 90 OHM DRIVER MOD.	10/90
S-1403		
1. SB-01:	LINE FUSE REPLACEMENT.	10/88
2. SB-02:	FIRMWARE UP-GRADE (VER 1.1)	3/89
3. SB-03:	FIRMWARE UP-GRADE (VER 1.2)	6/89
4. SB-04:	FIRMWARE UP-GRADE (VER 1.3)	4/90
5. SB-05:	FIRMWARE UP-GRADE (VER 1.4)	7/90
6. SB-06:	FIRMWARE UP-GRADE (VER 2.4)	7/90
7. SB-07:	FIRMWARE UP-DATE (VER 1.5)	12/90
* 8. SB-08:	FP CPU MOD - UNUSED LCD FIELDS	12/90
9. IB-01:	REPLY DELAY MEASUREMENTS (VER 1.4)	7/90
10. IB-02:	ATC-1400A FIRMWARE REQUIREMENTS	8/90
*11. IB-03:	NOTICE OF SB-08 RELEASE	12/90
MLS-800		
1. IB-01:	CRT ALIGNMENT PROCEDURES.	3/87
RDX/RDC-7708		
1. IB-01:	EXT. RF POWER MODULE ANNOUNCEMENT.	2/85
2. SB-01:	ECHO REPLY PC ASSY. MODIFICATION.	11/84
3. SB-02:	RF ASSY. AND CPU ASSY. INTERMITTENT SOCKETS.	12/84
4. SB-03:	POWER SUPPLY HEAT DISSIPATION.	12/84
5. SB-04:	FLOOR ASSY. MODIFICATION.	2/85
6. SB-05:	EXT. RF POWER MODULE RETROFIT.	9/85
STD-7000		
1. SB-01:	DC POWER SUPPLY REPLACEMENT.	12/84
DF-7708		
1. SB-01:	DATA LINE TRANSIENT SUPPRESSION.	12/88

* = CURRENT CHANGES 12/90

INFORMATION BULLETIN

S-1403 MODE S TEST SYSTEM
INFORMATION BULLETIN No. 3
FIRMWARE VERSION 1.5 EXTRA FIELDS

1. PURPOSE:

To notify customers with the S-1403 Test Auxiliary containing revision D or earlier Front Panel Processor PC Board and Firmware Version 1.5, Control Menu #2 displays two extra fields.

2. DESCRIPTION:

The S-1403, with revision D or earlier Front Panel Processor PC Board and Version 1.5 firmware incorporated, Control Menu #2 displays two fields not used at this time. Having the "Brf=" and "Brflv=" fields in the bottom line of the display does not affect operation. However, these unused fields are removable.

3. CORRECTIVE ACTION:

The modification for removing the unused fields is installed with S-1403 Service Bulletin No. 8, available upon request.

CONTACT: IFR SYSTEMS, INC
Customer Service Dept.
10200 West York Street
Wichita, Kansas 67215

Telephone: 800-835-2350
TWX: 910-741-6952

SERVICE BULLETIN

S-1403 MODE S TEST SYSTEM
SERVICE BULLETIN No. 8
FRONT PANEL PROCESSOR PC BOARD MODIFICATION
(7010-6830-200)

I. PLANNING INFORMATION:

A. Effectivity:

S-1403 Test Auxiliaries with Version 1.5 firmware installed and containing a Revision D or older Front Panel Processor PC Board.

B. Reasons:

Unused fields are displayed in Control Menu #2 screen. The Mode S Test System (S-1403/ATC-1400A) does not require calibration after performing modification outlined in this Service Bulletin.

C. Description:

The modification covered by this Service Bulletin eliminates the two unused fields in Control Menu #2 screen.

D. Manpower:

An estimated 0.75 hours are required to perform the subject modification and test the affected circuit.

The time required to test the S-1403 as a result of this modification is not affected.

E. Material - Cost and Availability:

The parts required to modify one S-1403 are listed in paragraph III.

F. Tooling Required - Price and Availability:

None.

G. References:

(1) Other Service Bulletins:

Installation of this Service Bulletin does not depend upon other Service Bulletins or modifications to the S-1403 Mode S Test System.

(2) Other Publications:

The next revision to the S-1403 Mode S Operation/Maintenance Manual will include changes described in this Service Bulletin.

II. ACCOMPLISHMENT INSTRUCTIONS:

A. Disassembly (Figure 1)

CAUTION

THIS EQUIPMENT CONTAINS PARTS
SENSITIVE TO DAMAGE
BY ELECTROSTATIC DISCHARGE (ESD)

STEP	PROCEDURE

1. Remove electrical power from the S-1403.
2. Remove two screws (2) securing top cover (1) and two screws (16) securing top mounting bracket (17).
3. Lift top cover (1) with top mounting bracket (17) from Chassis Assembly (3).
4. Remove eight screws (5) and both side frames (4) from Chassis Assembly (3).
5. Disconnect P10020 from J10020 (8) and P10021 from J10021 (9).
6. Remove four nuts (6) and and four washers (7) securing Front Panel Assembly (13).
7. Loosen four screws (10) securing bottom mounting bracket (12).
8. Lower bottom mounting bracket (12) and remove Front Panel Assembly (13) from Chassis Assembly (3).

   NOTE: Disconnecting cables is not necessary to perform this procedure.
9. Lay Front Panel Assembly (13) down with Front Panel Processor PC Board Assembly (15) facing up.
10. Remove six screws (14) and lift Front Panel Processor PC Board Assembly (15) from Front Panel Assembly (13).

B. Rework (Figure 2)

STEP	PROCEDURE

1. Configure Front Panel Processor PC Board for easiest access to backside pathwork.

II. ACCOMPLISHMENT INSTRUCTIONS

STEP	PROCEDURE
2.	Cut paths as shown.
3.	Install jumper wires as shown.

C. Reassembly

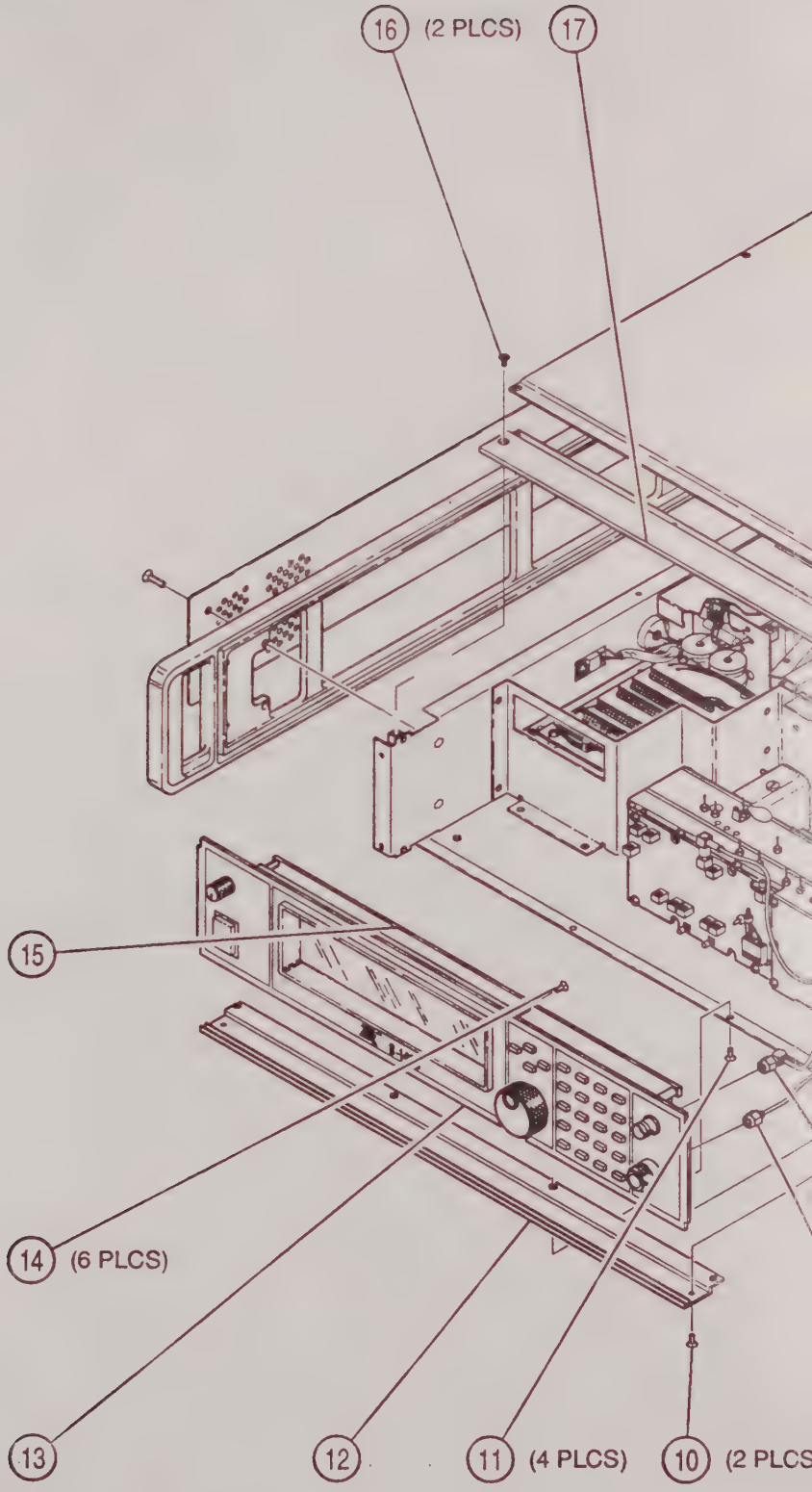
Reassemble in reverse order of disassembly instructions listed in paragraph IIA.

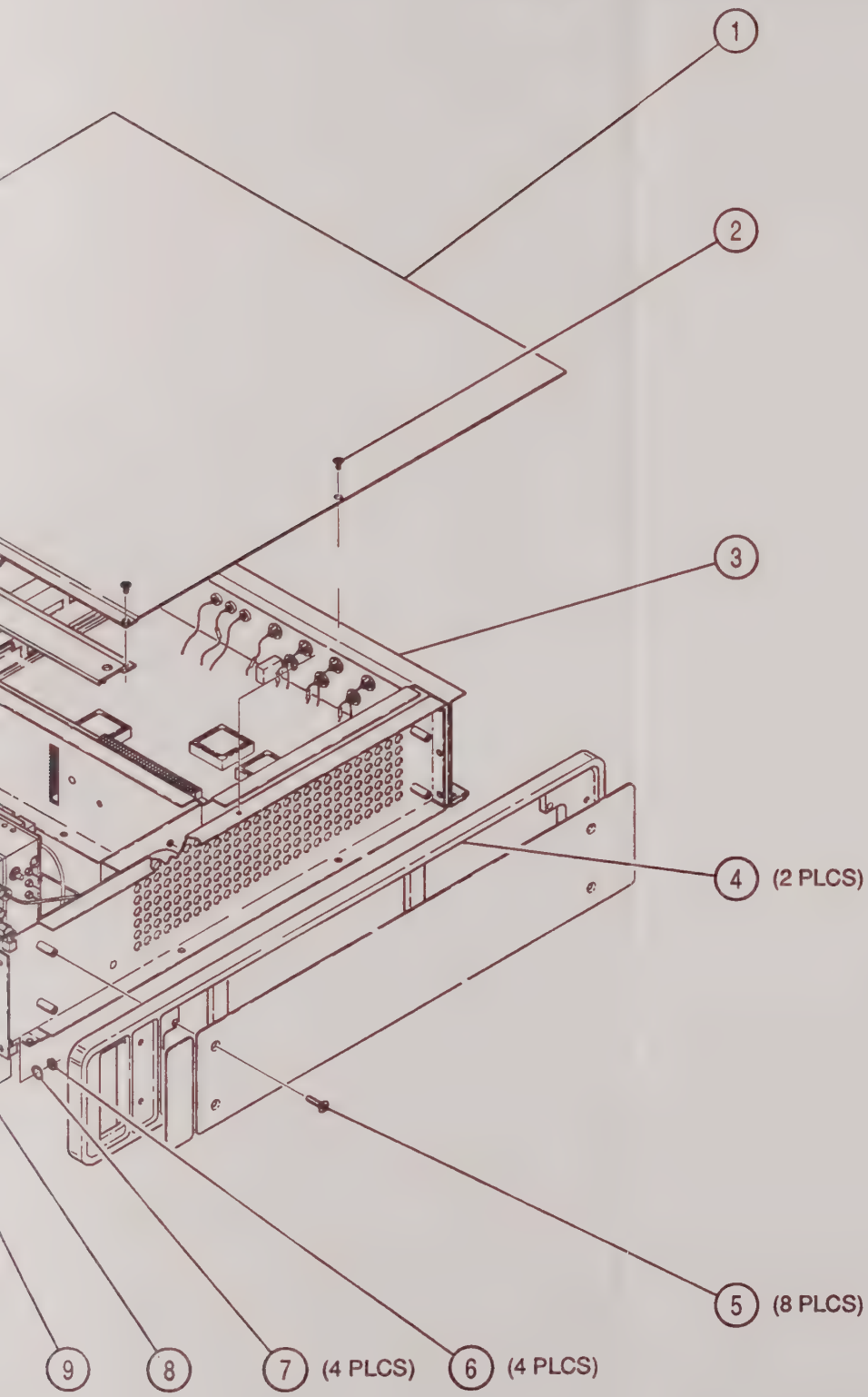
D. Testing Procedure

None.

III. MATERIAL INFORMATION

A length (enough to make two jumper wires) of 30 Guage Wire is required to modify one S-1403 Mode S Test System Test Auxiliary.


16 (2 PLCS)
17
15
14 (6 PLCS)
13
12
11 (4 PLCS)
10 (2 PLCS



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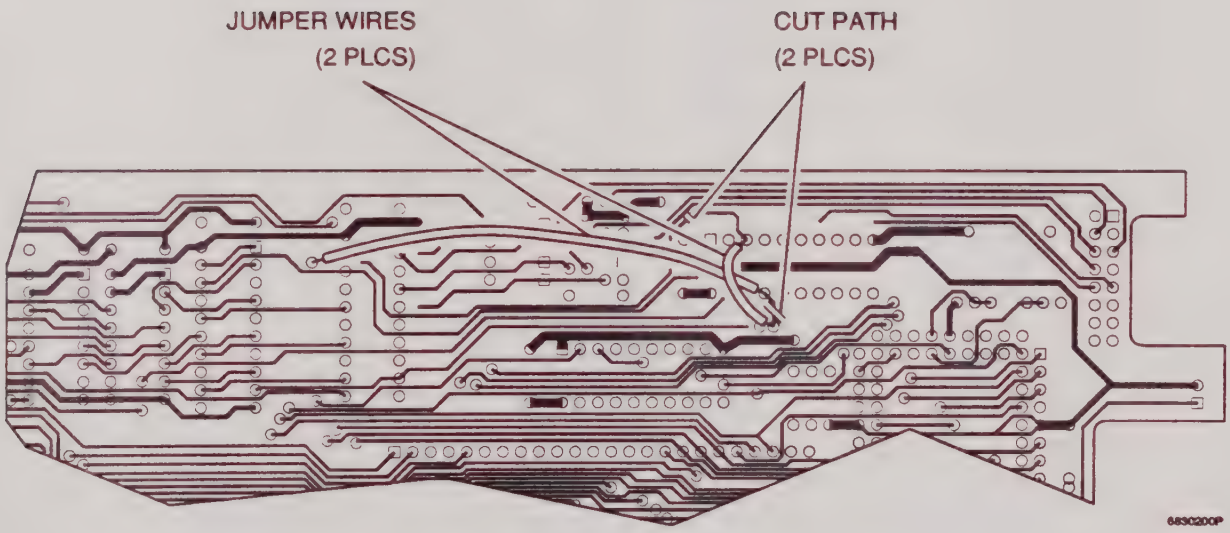
Front Panel Processor PC Board Assembly Removal

Figure 1



Front Panel Processor PC Board Assembly (7010-6830-200)
Figure 2

S-1403 MODE S SYSTEM
FIRMWARE REVISION OUTLINE

	FIRMWARE REVISION	EFFECTIVE SERIAL NO.	PAGE
	FRONT PANEL PROCESSOR PC ASSY.		1
	PULSE PC BOARD ASSEMBLY		2
	PROCESSOR PC BOARD ASSEMBLY		3
	1.1	3070	4
	1.2	3115	5
	1.3	3145	6
	1.4	3174	7
*	1.5	3229	8

* = CURRENT CHANGES

12/90

VERSION 1.5 * NOTE: ASTERISK (*) BELOW, MARKS E-PROM LOCATION(S) EFFECTED BY THIS UPDATE.
EFF: S/N 3229

E-PROM DATA:

1. PROCESSOR PC BD: 7010-6831-000
   U12002: 3271-6801-150 (V-1.5)*
   U12009: 3271-6802-150 (V-1.5)*

2. PULSE PC BD: 7010-6830-300
   U11005: 3263-6800-240 (V-2.4)

3. FRONT PANEL PC BD: 7010-6830-200
   U14003: 3271-6803-150 (V-1.5)*

ENHANCEMENTS:

1. "ATC" AND "DI" PREPULSE NOW ENABLED.
2. OVERALL SYSTEM SPEED AND GPIB RESPONSE TIME IMPROVED.
3. FRONT PANEL AND MAIN CPU VER # NOW DISPLAYED, AT POWER-UP.
4. GPIB COMMAND 'AX3=VER?' IS ANSWERED WITH BOTH CPU VER #.
5. GPIB DEVICE CLEAR CAUSES S-1403 TO REREAD ATC-1400A SWITCHES.

SYSTEM OPERATION MANUAL: 1002-6801-000
ILLUSTRATED PARTS LIST: 1002-6801-200
SYSTEM DATA - PACKAGE: 1007-6801-000

CORRECTIONS:

1. LCD SCREEN FLICKER REDUCED.
2. "AP ERROR" AND "DI ERROR" LCD DISPLAY MESSAGE PROBLEMS RESOLVED.
3. ATC, MODE-S AND ANTB % REPLY LIMITS NOW 0-999.
4. ANTENNA-B CW LEAKAGE ELIMINATED WHEN ANTENNA-B IS SWITCHED "OFF".
5. ATC1400A/S1403 NO LONGER TRANSMITTS INTERROGATION PULSES, WHEN POWERING-UP IN DME MODE.
6. GPIB COMMAND 'AX3=EXSYN' AUTOMATICALLY SWITCHED OFF WHEN CHANGING TO BURST MODE.
7. ANTENNA-A REPLY DELAY MEASUREMENTS NO LONGER EFFECTED WHEN ANTENNA-B IS SWITCHED ON/OFF.
8. ATC1400A 'INTERF-' CONTROL NO LONGER CAUSES ACS OR ACL MODE REPLY DELAY CALCULATION ERRORS.

IFR SYSTEMS, INC.

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ATC-601		
1. IB-01:	FIRMWARE VER 1.02 SELF TEST ERROR	11/90
ATC-1400A		
1. SB-01:	FIRMWARE UP-GRADE (VER 2.7)	2/88
2. SB-02:	FIRMWARE UP-GRADE (VER 4.01)	4/90
3. SB-03:	FIRMWARE UP-GRADE (VER 4.02)	8/90
T-1401		
1. SB-01:	LINE FUSE REPLACEMENT.	10/88
I-1402		
1. SB-01:	LINE FUSE REPLACEMENT.	10/88
2. SB-02:	MODE-4 90 OHM DRIVER MOD.	10/90
S-1403		
1. SB-01:	LINE FUSE REPLACEMENT.	10/88
2. SB-02:	FIRMWARE UP-GRADE (VER 1.1)	3/89
3. SB-03:	FIRMWARE UP-GRADE (VER 1.2)	6/89
4. SB-04:	FIRMWARE UP-GRADE (VER 1.3)	4/90
5. SB-05:	FIRMWARE UP-GRADE (VER 1.4)	7/90
6. SB-06:	FIRMWARE UP-GRADE (VER 2.4)	7/90
* 7. SB-07:	FIRMWARE UP-DATE (VER 1.5)	12/90
8. IB-01:	REPLY DELAY MEASUREMENTS (VER 1.4)	7/90
9. IB-02:	ATC-1400A FIRMWARE REQUIREMENTS	8/90
MLS-800		
1. IB-01:	CRT ALIGNMENT PROCEDURES.	3/87
RDX/RDC-7708		
1. IB-01:	EXT. RF POWER MODULE ANNOUNCEMENT.	2/85
2. SB-01:	ECHO REPLY PC ASSY. MODIFICATION.	11/84
3. SB-02:	RF ASSY. AND CPU ASSY. INTERMITTENT SOCKETS.	12/84
4. SB-03:	POWER SUPPLY HEAT DISSIPATION.	12/84
5. SB-04:	FLOOR ASSY. MODIFICATION.	2/85
6. SB-05:	EXT. RF POWER MODULE RETROFIT.	9/85
STD-7000		
1. SB-01:	DC POWER SUPPLY REPLACEMENT.	12/84
DF-7708		
1. SB-01:	DATA LINE TRANSIENT SUPPRESSION.	12/88

* = CURRENT CHANGES 12/90

SERVICE BULLETIN

S-1403 MODE S TEST SYSTEM
SERVICE BULLETIN No. 7
FIRMWARE VERSION 1.5 INSTALLATION
(7010-6831-000) (7010-6830-200)

I. PLANNING INFORMATION:

A. Effectivity:

S-1403 Mode S Test System S/N 3001 thru S/N 3228.

B. Reasons:

New EPROMs (Version 1.5 software) eliminate deficiencies associated with earlier software versions, add capabilities and enhance existing capabilities. The Mode S Test System (S-1403/ATC-1400A) does not require calibration after performing the modification outlined in this Service Bulletin.

C. Description:

The modifications covered by this Service Bulletin (Version 1.5 software) incorporate the following:

(1) Added GPIB command, "AX3=VER?", obtains firmware version number of both processors (Processor PC Board and Front Panel Processor PC Board).

(2) On power up, the front panel displays firmware version numbers for both processors (Processor PC Board and Front Panel Processor PC Board).

(3) The S-1403 rereads ATC-1400A switches with GPIB Device Clear command.

(4) Prepulse in ATC and DI modes can be enabled.

(5) Time to program pulses is reduced, improving GPIB response to pulse reprogramming commands (refer to GPIB Program Timing Table, Table 1).

(6) Overall system speed is increased by converting to more efficient C compiler.

(7) LCD screen flicker is reduced.

(8) Intermittent loss of output is eliminated.

(9) Interrogation pulses are no longer transmitted by the ATC-1400A/S-1403 when powered up in the DME mode.

(10) LCD display error message problems (not flashing or not going away) including all AP and DI error problems are corrected.

(11) The scope trigger in BURST mode for ACS or ACL functions correctly and is output in the same format as in the ACS or ACL modes.

(12) In BURST mode, ATC-1400A DME Range, Velocity and Distance displays indicate OFF instead of 000.

I. PLANNING INFORMATION:

(13) The PPMG selection on CMENU2 functions correctly from the front panel user interface and GPIB.

(14) Reply delay measurements are correct when receiving replies through Antenna-A when Antenna-B is ON.

(15) GPIB command, "AX3=EXSYN" is automatically turned OFF when changing modes to BURST.

(16) In ACS or ACL modes, INTERF- from the ATC-1400A no longer causes improper reply delay calculations.

(17) "Long Data" entry in the SEQ MENU now prevents improper data from being entered in the most significant character position (correct range is now "0" to "3").

(18) Switching Antenna-B OFF turns the internal oscillator off, eliminating any CW leakage through the Antenna-B Connector.

D. Manpower:

An estimated 0.75 hours are required to perform the subject modification and test the affected circuit.

The time required to test the S-1403 as a result of this modification is not affected.

E. Material - Cost and Availability:

The parts required to modify one S-1403 are listed in paragraph III. The parts are available for shipment within 30 days after receipt of order at a price of $150.00 (price subject to change without notice). The parts may be obtained from the factory customer service department. All orders should specify the IFR part number of the desired components and reference Service Bulletin No. 7.

A refund credit ($50.00 per EPROM) is effective when IFR Systems, Inc. receives replacement EPROMs and serial number(s) of unit(s) modified.

F. Tooling Required - Price and Availability:

None.

G. References:

(1) Other Service Bulletins:

Installation of this Service Bulletin does not depend upon other Service Bulletins or modifications to the S-1403 Mode S Test System.

(2) Other Publications:

The next revision to the S-1403 Mode S Operation/Maintenance Manual will include changes described in this Service Bulletin.

II. ACCOMPLISHMENT INSTRUCTIONS:

A. Disassembly (Figure 1):

STEP	PROCEDURE

1. Remove electrical power from the S-1403.
2. Release both DZUS fasteners (1) and remove the Processor PC Board Assembly (2).
3. Remove top cover (4) from S-1403 to expose the Front Panel Processor PC Board Assembly (3).

B. Rework (Figures 2 and 3):

STEP	PROCEDURE

CAUTION: TO REMOVE ANY EPROM, CAREFULLY LIFT UP ON ONE END OF EPROM WITH STATIC-FREE TOOL AND LIFT EPROM STRAIGHT UP TO AVOID DAMAGING LEADS. IMMEDIATELY PLACE EPROM IN A STATIC-FREE BAG.

CAUTION: TO REPLACE ANY EPROM, CAREFULLY GRASP ENDS OF EPROM AND REMOVE FROM STATIC-FREE MATERIAL. THEN, OBSERVING CORRECT PLACEMENT ON SOCKET, INSERT LEADS STRAIGHT DOWN INTO SOCKET. GENTLE PRESSURE WILL ENSURE CORRECT SEATING OF EPROM.

CAUTION: DO NOT ALLOW ANY SURFACES, INCLUDING FINGERS, TO COME IN CONTACT WITH THE EPROM LEADS. ALIGNMENT OF SOME EPROM PINS INTO SOCKET MAY REQUIRE A NON-STATIC, NON-CONDUCTIVE PROBE.

Processor PC Board Assembly Operation Memory Replacement (Figure 2)

1. Orientate Processor PC Board Assembly (3) as shown in Figure 2.
2. Remove EPROM U12009 (1).
3. Install new EPROM, P/N 3271-6802-150, into empty U12009 socket per Figure 2.
4. Remove EPROM U12002 (2).
5. Install new EPROM, P/N 3271-6801-150, into empty U12002 socket per Figure 2.
6. Reinstall Processor PC Board Assembly (3) into S-1403.

II. ACCOMPLISHMENT INSTRUCTIONS:

STEP PROCEDURE

Front Panel Processor PC Board Assembly Operation Memory Replacement (Figure 3).

7. Remove EPROM U14003 (2) from Front Panel Processor PC Board Assembly (1).

8. Install new EPROM, P/N 3271-6803-150, into empty U14003 socket per Figure 3.

C. Reassembly:

Reassemble in reverse order of disassembly instructions listed in paragraph IIA.

D. Testing Procedure:

None.

III. MATERIAL INFORMATION:

The following parts are required to modify one S-1403 MODE S TEST SYSTEM TEST AUXILIARY.

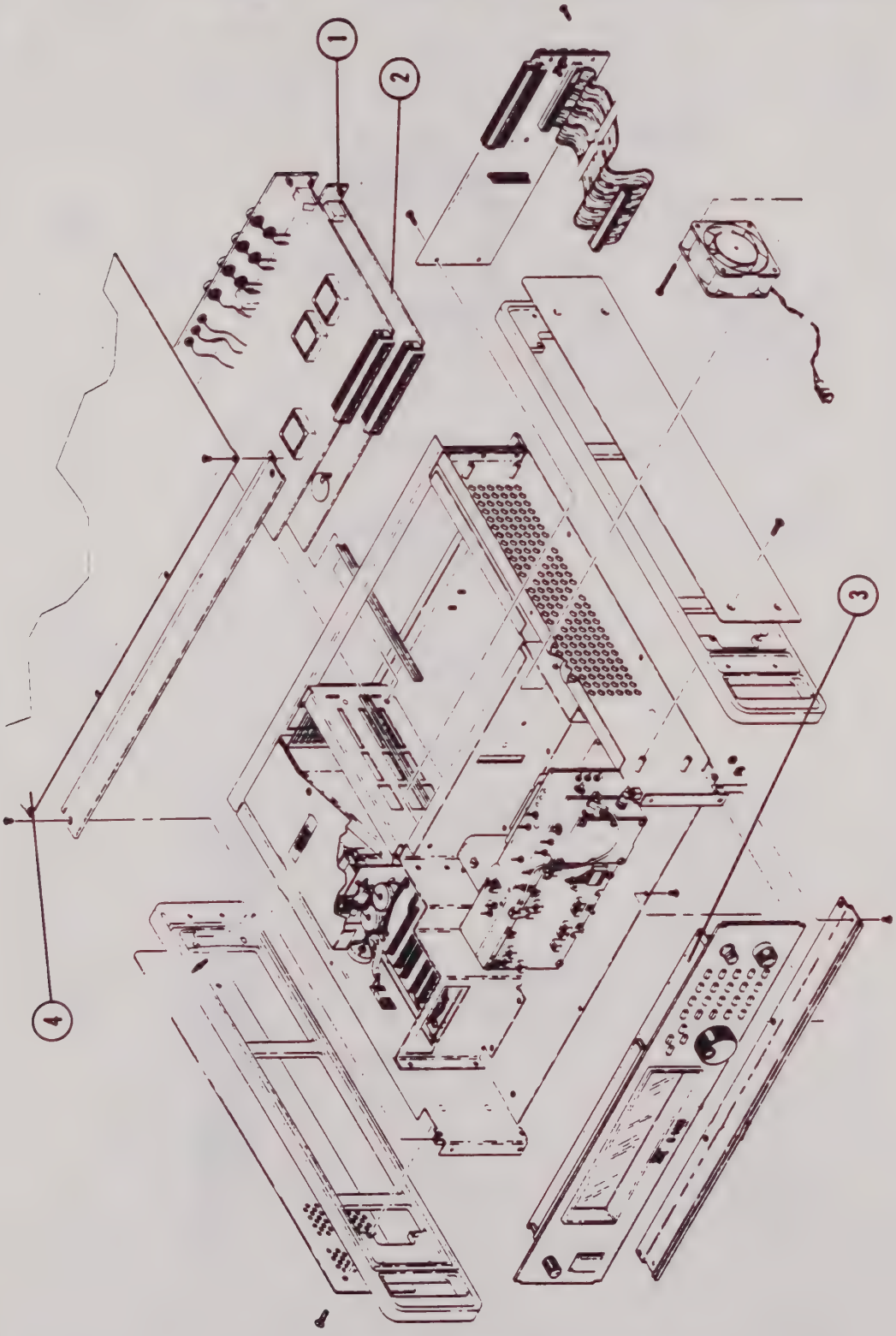
IFR PART NUMBER	QTY	DESCRIPTION	UNIT PRICE	TOTAL PRICE
3271-6801-150	1	Firmware EPROM	$50.00	$50.00
3271-6802-150	1	Firmware EPROM	$50.00	$50.00
3271-6803-150	1	Firmware EPROM	$50.00	$50.00

Mode	Program Timing for Version 1.5	
ATC	60 ms	
SEQ	85 ms for 1 short	
	98 ms for 1 long	
	128 ms for 2: 1 long, 1 short	
	159 ms for 3: 1 long, 2 short	
	201 ms for 4: 2 long, 2 short	
	140 ms for 2 long	
	117 ms for 2 short	
ACS or ACL	60 ms	
BURST	ATC	59 ms
	SEQ with PRF <400	116 ms for 2 short
		139 ms for 2 long
	SEQ with PRF >400	138 ms for 1 long 1150 PRF
		138 ms for 1 long 2250 PRF
		168 ms for 2 long 2250 PRF

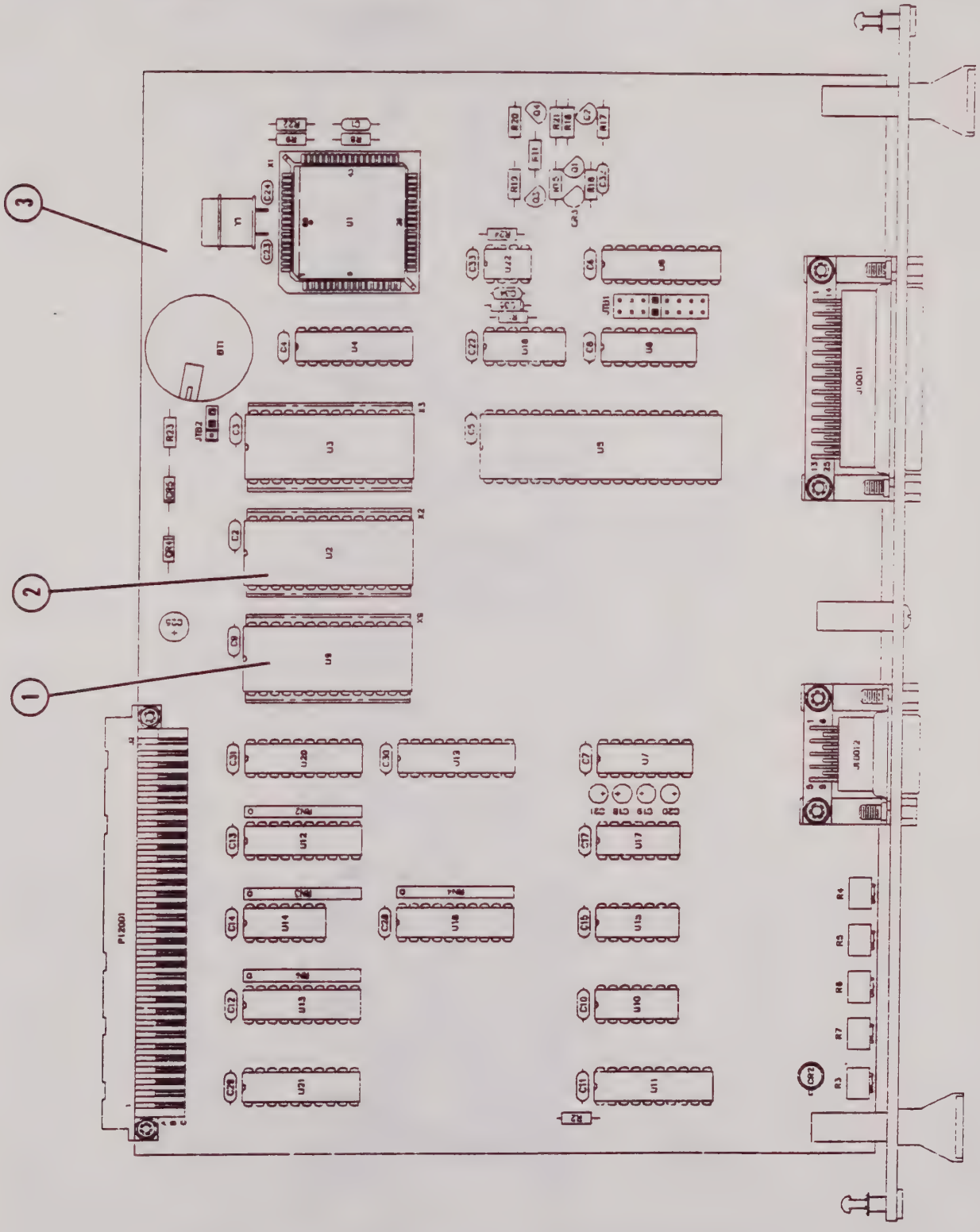
NOTE: Estimate 55 ms for entering routine.
31 ms to program each short.
42 ms to program each long.

NOTE: Add GPIB overhead (variable depending on ATC1400A and S-1403.

GPIB Program Timing Table
Table 1



S-1403 Composite Assembly
Figure 1



Processor PC Board Assembly (7010-6831-000)
Figure 2

WARNING:

HIGH VOLTAGE EQUIPMENT

THIS EQUIPMENT CONTAINS CERTAIN CIRCUITS AND/OR COMPONENTS OF EXTREMELY HIGH VOLTAGE POTENTIALS, CAPABLE OF CAUSING SERIOUS BODILY INJURY OR DEATH. WHEN PERFORMING ANY OF THE PROCEDURES CONTAINED IN THIS MANUAL, HEED ALL APPLICABLE SAFETY PRECAUTIONS.

RESCUE OF SHOCK VICTIMS

1. DO NOT ATTEMPT TO PULL OR GRAB THE VICTIM
2. IF POSSIBLE, TURN OFF THE ELECTRICAL POWER.
3. IF YOU CANNOT TURN OFF ELECTRICAL POWER, PUSH, PULL OR LIFT THE VICTIM TO SAFETY USING A WOODEN POLE, A ROPE OR SOME OTHER DRY INSULATING MATERIAL.

FIRST AID

1. AS SOON AS VICTIM IS FREE OF CONTACT WITH SOURCE OF ELECTRICAL SHOCK, MOVE VICTIM A SHORT DISTANCE AWAY FROM SHOCK HAZARD.
2. SEND FOR DOCTOR AND/OR AMBULANCE.
3. KEEP VICTIM WARM, QUIET AND FLAT ON HIS/HER BACK.
4. IF BREATHING HAS STOPPED , ADMINISTER ARTIFICIAL RESUSCITATION. STOP ALL SERIOUS BLEEDING.

CAUTION: INTEGRATED CIRCUITS AND SOLID STATE DEVICES SUCH AS MOS FET'S, ESPECIALLY CMOS TYPES, ARE SUSCEPTIBLE TO DAMAGE BY ELECTROSTATIC DISCHARGES RECEIVED FROM IMPROPER HANDLING, THE USE OF UNGROUNDED TOOLS, AND IMPROPER STORAGE AND PACKAGING. ANY MAINTENANCE TO THIS UNIT MUST BE PERFORMED WITH THE FOLLOWING PRECAUTIONS:

1. BEFORE USING IN A CIRCUIT, KEEP ALL LEADS SHORTED TOGETHER EITHER BY THE USE OF VENDOR-SUPPLIED SHORTING SPRINGS OR BY INSERTING LEADS INTO A CONDUCTIVE MATERIAL.

2. WHEN REMOVING DEVICES FROM THEIR CONTAINERS, GROUND THE HAND BEING USED WITH A CONDUCTIVE WRISTBAND.

3. TIPS OF SOLDERING IRONS AND/OR ANY TOOLS USED MUST BE GROUNDED.

4. DEVICES MUST NEVER BE INSERTED INTO NOR REMOVED FROM CIRCUITS WITH POWER ON.

5. PC BOARD, WHEN TAKEN OUT OF THE SET, MUST BE LAID ON A GROUNDED CONDUCTIVE MAT OR STORED IN A CONDUCTIVE STORAGE BAG.

   NOTE: Remove any built-in power source, such as a battery, before laying PC Boards on conductive mat or storing in conductive bag.

6. PC BOARDS, IF BEING SHIPPED TO THE FACTORY FOR REPAIR, MUST BE PACKAGED IN A CONDUCTIVE BAG AND PLACED IN A WELL-CUSHIONED SHIPPING BOX.

THE USE OF SIGNAL GENERATORS FOR MAINTENANCE AND OTHER ACTIVITIES CAN BE A SOURCE OF ELECTROMAGNETIC INTERFERENCE TO AVIATION RECEIVERS, WHICH CAN CAUSE DISRUPTION AND INTERFERENCE TO AERONAUTICAL SERVICE OUT TO A DISTANCE OF SEVERAL MILES.

USERS OF THIS EQUIPMENT SHOULD SCRUTINIZE ANY OPERATION WHICH RESULTS IN RADIATION OF A SIGNAL (DIRECTLY OR INDIRECTLY) AND ENSURE COMPLIANCE WITH INSTRUCTIONS OUTLINED IN FAA CIRCULAR AC 170-6C, DATED FEBRUARY 19, 1981.

RECORD OF REVISIONS

REV NO.	ISSUE DATE	DATE INSERTED	BY	REV NO.	ISSUE DATE	DATE INSERTED	BY

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INTRODUCTION - MODE S TEST SYSTEM

This manual contains the information necessary to install, operate, test and maintain the S-1403 Mode S Auxiliary. It is designed for use with the ATC-1400A Operation/Maintenance Manual. Interfacing the S-1403 Mode S Auxiliary with the ATC-1400A Transponder/DME Test Set forms the Mode S Test System. The additional GPIB commands required for testing ATC Mode S Transponders are listed in Section 1-2-4 of this manual.

It is strongly recommended that personnel be thoroughly familiar with the contents of this manual and the contents of the ATC-1400A Operation/Maintenance Manual before attempting to operate or service this equipment.

ORGANIZATION:

This manual is divided into the following Chapters and Sections:

CHAPTER/SECTION

1-1 DESCRIPTION - An introduction to the Mode S Test System, explaining its functions, and including a composite drawing for module identification.

1-2 OPERATION - Contains detailed instructions for:

INSTALLATION - Procedures to set up the Mode S Test System for testing ATC Mode S Transponders; and instructions for interfacing the Mode S Test System to the ATC-1400A Transponder/DME Test Set.

CONTROLS - A complete description of Controls, Connectors and Indicators for the Mode S Test System.

SYSTEM OPERATION - A complete description of controls, connectors and indicators by test function and command formats for testing ATC Mode S Transponders.

REMOTE (GPIB) OPERATION - A complete description of the commands required to operate the S-1403 utilizing IEEE-488 Bus connected to the ATC-1400A

PERFORMANCE VERIFICATION - Provides functional check-out procedures for evaluating the performance of the Mode S Test System.

CHAPTER/SECTION

1-3	SPECIFICATIONS -	Contains a detailed list of specifications for the Mode S Test System.
1-4	SHIPPING -	Provides repacking procedures for shipment.
1-5	STORAGE -	Provides storage instructions for extended periods of non-use.

CHAPTER ONE

MODE S TEST SYSTEM

OPERATION MANUAL

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SECTION 1 - DESCRIPTION

1. General Description and Capabilities

A. Description

The S-1403/ATC-1400A Test System provides transponder pulse code modulation for the purpose of testing ATCRBS (Air Traffic Control Radar Beacon) and Mode Select Transponders. It can be operated manually using front panel controls and switches, or remotely by ATE (Automatic Test Equipment) control through the GPIB (General Purpose Interface Bus).

B. Features

The S-1403/ATC-1400A Test System incorporates the following test features:

(1) Air Traffic Control Radar Beacon System (ATC) Test Function

(2) Programmable Mode S Sequence (SEQ) Test Function

(3) All Call Short (ACS) Test Function

(4) All Call Long (ACL) Test Function

(5) Interlacing (INTLCE) Mode S with ATC Test Function

(6) Double Interrogation (DI) Test Function

(7) BURST Test Function

(8) An RF output at a fixed frequency and output level for diversity antenna testing.

(9) A vernier level control which provides an additional 3.0 dB RF output power in 0.1 dB steps for all modes.

(10) A four-line by forty-column indicator for displaying all important Mode S parameters.

(11) Twenty-four position keypad for numerical data entry, function selection and cursor control.

(12) Continuous rotation "SLEW" Control which can be used as an alternate to key entry.

(13) A battery backup memory for saving all front panel selections plus storage for an additional test setup.

(14) A menu to allow operator input and monitoring of uplink and downlink formats.

(15) Programmable sixteen-item sequence for uplink and downlink format information.

(16) Remote operation through ATC-1400A IEEE-488 1978 interface port.

(17) Rear panel interconnects for control and signal monitoring.

(18) P4 and P6 width and offset; P4 and P5 amplitude control.

(19) Synchronous Phase Reversal (SPR) offset control with respect to P6 rising edge.

C. System Overview

The Mode S Test System consists of seven test functions which provide all of the pulse modulation needed to verify the proper operation of a Mode S transponder. These functions allow the operator to simulate:

(1) An ATCRBS environment (ATC Function) which an ATC ground system is transmitting a standard two-pulse interrogation and expecting either a Mode A or Mode C reply. The S-1403 has the additional capability to decode and display Mode S Squitter replies, allowing the operator to determine the aircraft address.

(2) A Mode S environment (SEQ Function) in which a ground or airborne (TCAS) interrogator can transmit a number of uplink formats to the Mode S transponder and decode it's downlink format replies. Up to sixteen unique uplink formats may be programmed with their accompanying replies displayed on each of the S-1403 Sequence Menu displays.

(3) An intermode environment (INTLCE Function) in which both ATCRBS and Mode S interrogations are interlaced at a normal ratio of ten ATCRBS per one Mode S.

For all these environmental simulations, the S-1403 in conjunction with the ATC-1400A, provides control for all pulse parameters for testing the limits of operation of the Unit Under Test (UUT). Indication of proper operation is provided by percent reply displays that discriminate between ATCRBS and Mode S replies. In addition to these common signal environment simulations, the Mode S Test System provides means of testing both minimum interrogation spacing (DI Test Function) and rate limiting (BURST Test Function).

The ACS (All Call Short) and ACL (All Call Long) Test Functions provide a quick and convenient way to determine if the transponder is replying properly as either ATCRBS or Mode S. These functions provide full control over the P_4 pulse characteristics to determine the proper response.

Diversity testing is also possible in all functions by enabling ANT B. This tests the UUT's ability to switch antennas by simulating a disparity in amplitude or time from the ANT A to the ANT B output.

Detailed explanation of the operation of each of the seven functions is provided in the subsequent paragraphs. The user should read these paragraphs as well as review the associated timing diagrams before proceeding.

The outer 26-pin ribbon cable connection (Auxiliary) is used to transmit high speed clock (20 Mhz) and pulse video information from the ATC-1400A to the S-1403. The S-1403 uses the clock input for all pulse generation (interrogation) functions for both ANT A (ATC-1400A RF I/O) and ANT B output. This connector also inputs the reply video information received from ANT A, which the S-1403 uses to measure the necessary reply pulse parameters. The ATC-1400A also provides a synchronization signal called Self Interrogation which is driven by the ATC-1400A PRF generator. This signal is used to "drive" every function unless the EXT SYNC IN control has been turned ON. Control of the ATC-1400A SLS enable gate is also provided through this connector.

The inner 2- pin ribbon cable connection allows the two units (the S-1403 and the ATC-1400A) to communicate control and data information over a proprietary "IFR BUS". Upon power-on, after each unit has performed its respective initialization sequence, the S-1403 will transmit to the ATC-1400A the control output and data input locations within the ATC-1400A that it wishes to override and monitor. From this point until the next power down, the S-1403 will maintain primary control over the selected ATC-1400A functions. This connection also allows ASCII GPIB commands to be relayed to the S-1403 for execution and relays return data back to the ATC-1400A GPIB interface.

The three coaxes provide direct control, by the S-1403, of the ATC-1400A's:

RF Level by raising or lowering an analog signal on the RF Vernier Output Connector that is sent directly to the ATC-1400A Modulator for a ±3 dB offset.

A digital drive from the S-1403 directly to the ATC-1400A Phase Modulator for DPSK transitions in the ANT A interrogation output (Mode S).

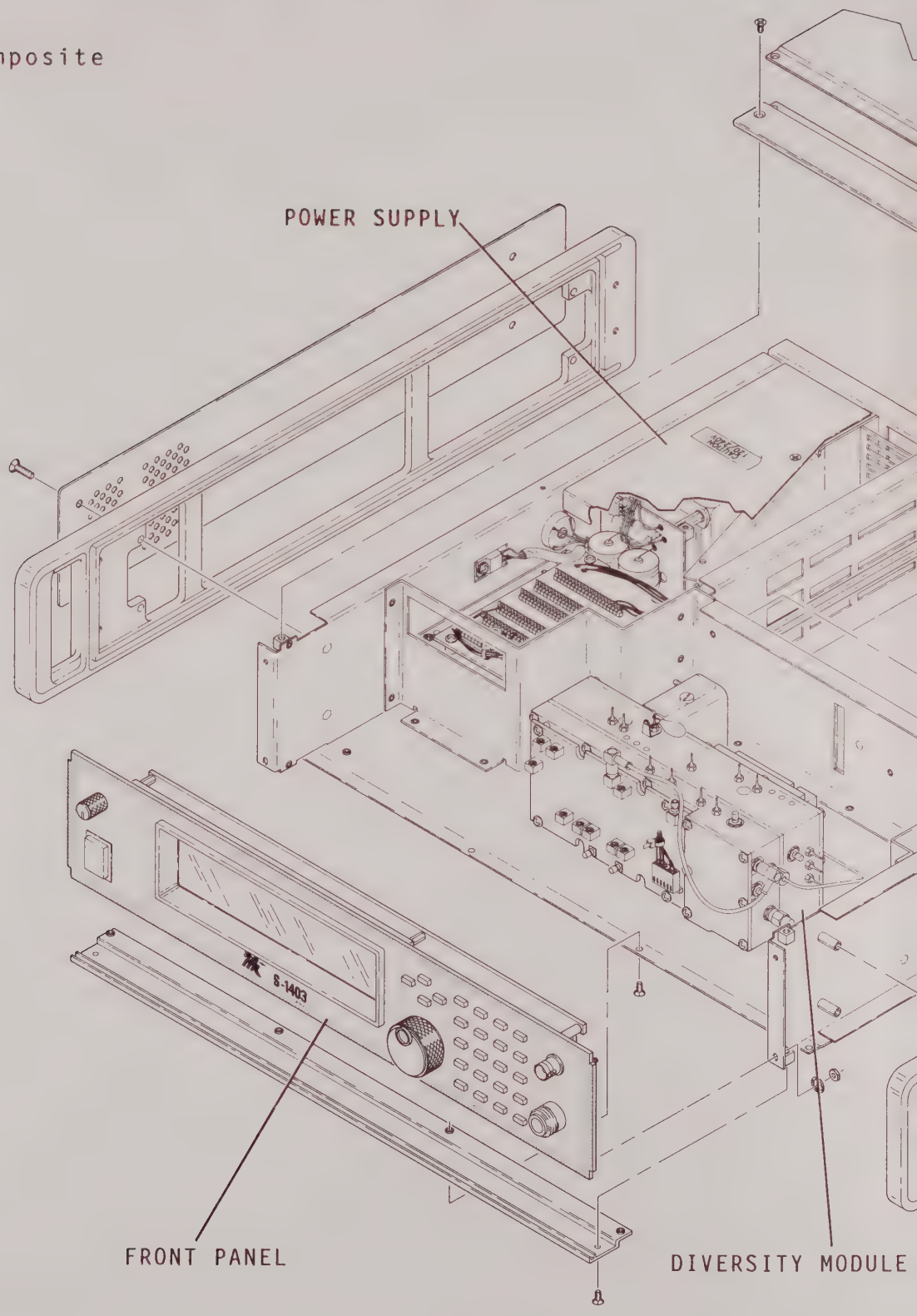
A gating control signal on the Measurement Gate Output that enables the ATC-1400A power meter circuit.

The remaining interfaces on the rear of the S-1403 are used in the performance of a test and are explained in detail later.

The S-1403's LCD display provides many supplemental display and control fields to the ATC-1400A. Nearly all of the ATC-1400A's display and switch inputs have been left active as well. Those still used are listed in the following chapter along with a description of their use. Users of the this system who are familiar with the ATC-1400A operation should have little trouble understanding the use of the S-1403/ATC-1400A System. Some of the ATC-1400A switch operations are defined differently in this manual so as to better represent their modified use as a system control. Also some of the System Specifications have been altered from the ATC-1400A specifications.

In every case, the S-1403/ATC-1400A System Specification take precedence over the ATC-1400A specifications.

D. Composite



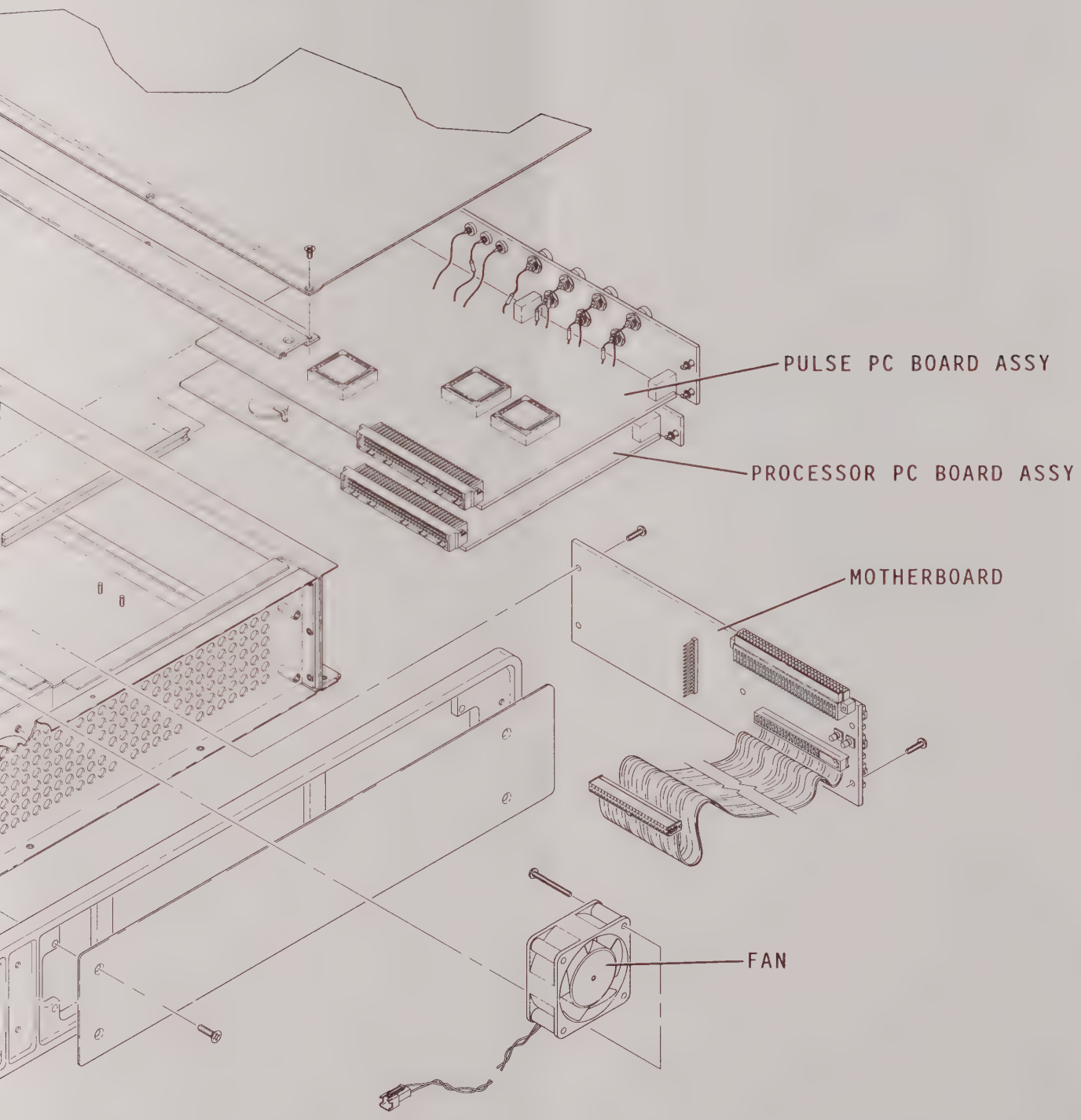
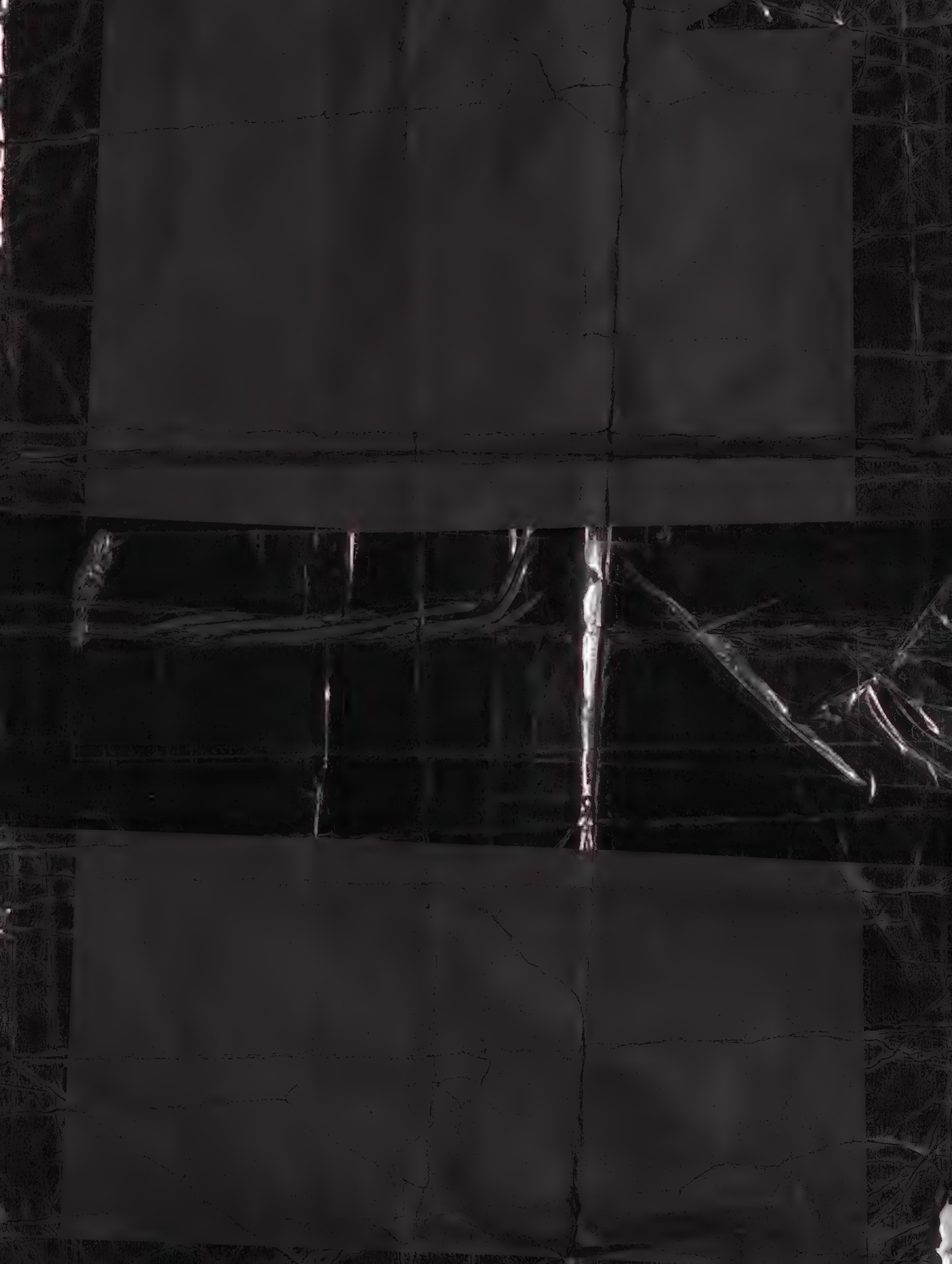


Figure 1 S-1403 Composite
(Module Identification)



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SECTION 2 - OPERATION

1. INSTALLATION

Installation of the Mode S Test System is a simple procedure:

(1) Set the instrument into an operating position.

(2) Furnish electrical power to the test set by connecting an AC power cable to available power source (either 105 to 120 VAC or 220 to 250 VAC, 50 to 400 Hz, 10 W).

This section includes recommendations regarding installation and operating safety, equipment inspection, power requirements, required installation tools and bench/rack installation.

A. Safety Precautions

Listed below are several important precautions which must be observed during all phases of system installation and operation. IFR Systems, Inc., assumes no liability for customer's failure to comply with any of the safety precautions outlined in this manual.

(1) Complying with Instructions

Installation/operating personnel should not attempt to install or operate the system without reading and complying with all instructions contained in this manual. All procedures contained in this manual must be performed in the exact sequence and in the manner described.

(2) Grounding Requirements

WARNING: DUE TO POTENTIAL SAFETY HAZARDS, USE OF A THREE-PRONG TO TWO-PRONG ADAPTER PLUG IS NOT RECOMMENDED.

TO MINIMIZE SHOCK HAZARD, ALL EQUIPMENT CHASSIS AND CABINETS MUST BE CONNECTED TO AN ELECTRICAL GROUND. FOR THIS PURPOSE, ALL IFR SYSTEMS, INC., TEST SETS ARE EQUIPPED WITH A STANDARD THREE-PRONGED POWER CABLE WHICH MUST BE CONNECTED TO A PROPERLY GROUNDED THREE-PRONG WALL RECEPTACLE. TO SUMMARIZE, IT IS THE CUSTOMER'S RESPONSIBILITY TO:

HAVE A QUALIFIED ELECTRICIAN CHECK ALL RECEPTACLE(S) FOR PROPER GROUNDING.

REPLACE ANY STANDARD TWO-PRONGED RECEPTACLE(S) WITH PROPERLY GROUNDED THREE-PRONG RECEPTACLE(S).

(3) Operating Safety

Because of potentially lethal voltages within test equipment, operating personnel must not remove test equipment covers at any time. Component replacement and internal adjustments must be made by qualified maintenance personnel only.

(4) Observing "CAUTION" and "WARNING" Labels

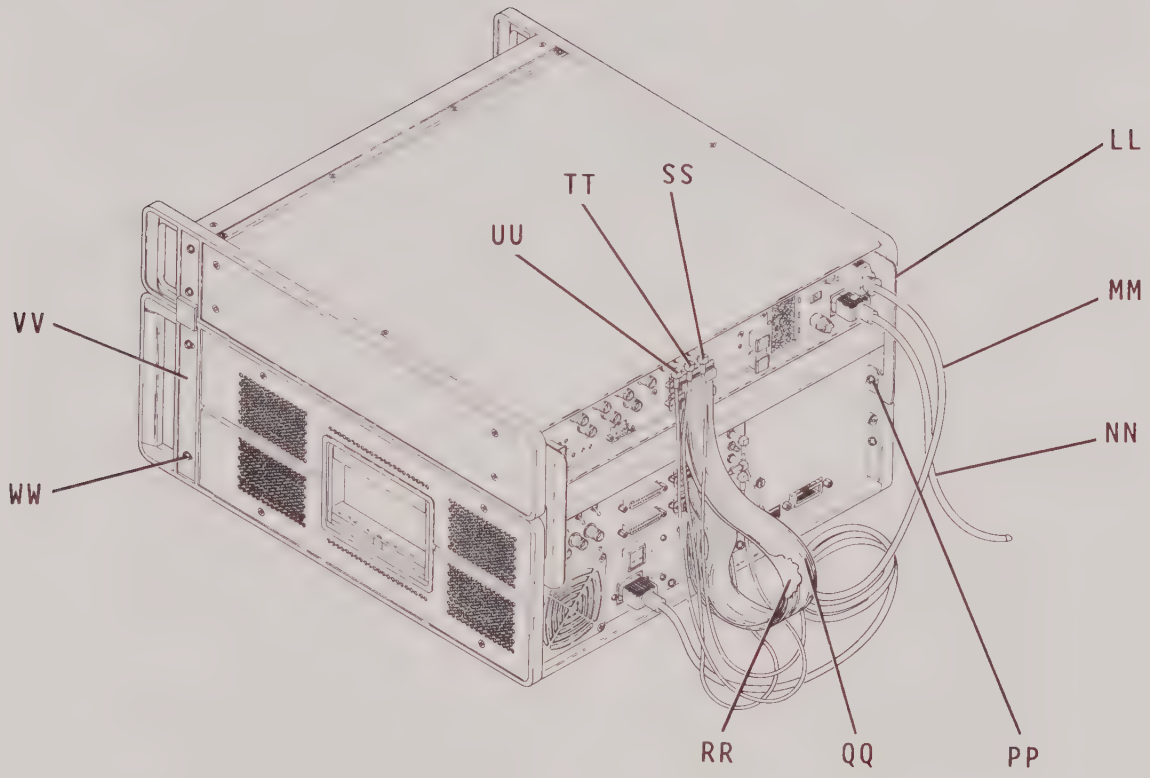
Extreme care should be exercised when performing any operations preceded by a "CAUTION" or "WARNING" label. "CAUTION" labels appear where possibility of damage to equipment exists, while "WARNING" notes are used to denote a condition where a shock hazard exists, exposing personnel to possible bodily injury or death.

B. Equipment Inspection

All IFR Systems, Inc., test sets are carefully inspected for material defects and are subjected to a thorough performance check prior to leaving the factory. All sets are shipped to customer in excellent mechanical/electrical condition. Upon receipt of shipment, receiving personnel should:

Account for presence of all equipment and accessories as listed on packing slip.

Inspect all equipment for visible or concealed damage which may have occurred in transit. If damage is apparent, see "RECEIVING INSPECTION/UNPACKING" sticker affixed to shipping container for "Damage Claim" procedure.



LL. Rear Bracket
MM. ATC-1400A Power Cable
NN. S-1403 Power Cable
PP. Attaching Screws
QQ. 25 Pin D-Style Ribbon Cable (J10011 to J5 [IFR BUS])
RR. 25 Pin D-Style Ribbon Cable (J10010 to J6 [AUXILIARY])
SS. SMB-SMB Coax Cable (J10013 to J4)
TT. SMB-SMB Coax Cable (J10014 to J3)
UU. SMB-SMB Coax Cable (J10015 to J1)
VV. Front Bracket
WW. Attaching Screws

Figure 1 S-1403 to ATC-1400A Interface

C. Power Requirements

Mode S power supply can operate over a voltage range of 105 to 120 or 210 to 250 VAC. No internal wiring changes are required prior to applying AC power to the test auxiliary. To select between 120 VAC and 220 VAC, ensure LINE Switch (N) setting on rear panel matches input line voltage. Instantaneous surge current at power up is less than 50 Amps. Input current varies to maintain constant power over the input voltage range (approximately 10 W), so it is important that the fuse selected has the correct rating for proper operation. The recommended fuse ratings are listed below:

INPUT VOLTAGE	F1 - AC IN FUSE	F2 - AC OUT VOLTAGE
105 to 120 VAC	3.0A 250V Fast Blo	1.0A 250V Fast Blo
220 to 250 VAC	3.0A 250V Fast Blo	0.5A 250V Fast Blo

D. Installation Equipment

All electrical connections required to ready the instrument for operation can be easily made by hand, without using special tools.

E. Installation Procedure

The S-1403 and ATC-1400A are shipped in separate containers. To prepare the units for operation, proceed as follows:

STEP	PROCEDURE
1.	Remove both the S-1403 and ATC-1400A Test Sets from their respective containers.
2.	Place the S-1403 on top of the ATC-1400A.
3.	Connect the two 25-pin type D ribbon cables, three SMB-to-SMB coax cables, two power cables and attaching hardware to test sets as shown in Figure 2.
4.	Calibrate the Mode S Test System per Section 2-2-2 Paragraph H(4), System Calibration. The System must be calibrated any time the S-1403 is replaced.

The S-1403, when interfaced with the ATC-1400A, can be installed in either a bench-top or rack-mount fashion. All IFR Systems, Inc., test sets are normally shipped from factory with plastic feet installed for a bench-top installation. Conversion from bench-top to rack-mount installation is possible by ordering the following rack-mount kits:

One kit per instrument is required for installation.

CAUTION: SPECIAL CARE MUST BE TAKEN TO AVOID RESTRICTION OF AIR FLOW TO INTAKE VENT, WHEN INSTALLING INSTRUMENT IN EITHER A BENCH-TOP OR RACK-MOUNT FASHION.

Instrument	IFR Systems Part Number
ATC-1400A	7001-7636-800
S-1403	7001-6740-800

F. Power-up Procedure

Remove 3-conductor AC power cable from S-1403 shipping container and connect female end to AC IN Connector (L) on rear panel of S-1403. Connect 3-pin grounded plug on opposite end of AC power cable to standard 3-pin grounded receptacle.

Place POWER Switch (G) to "ON" Position to energize test set and verify POWER Switch is illuminated.

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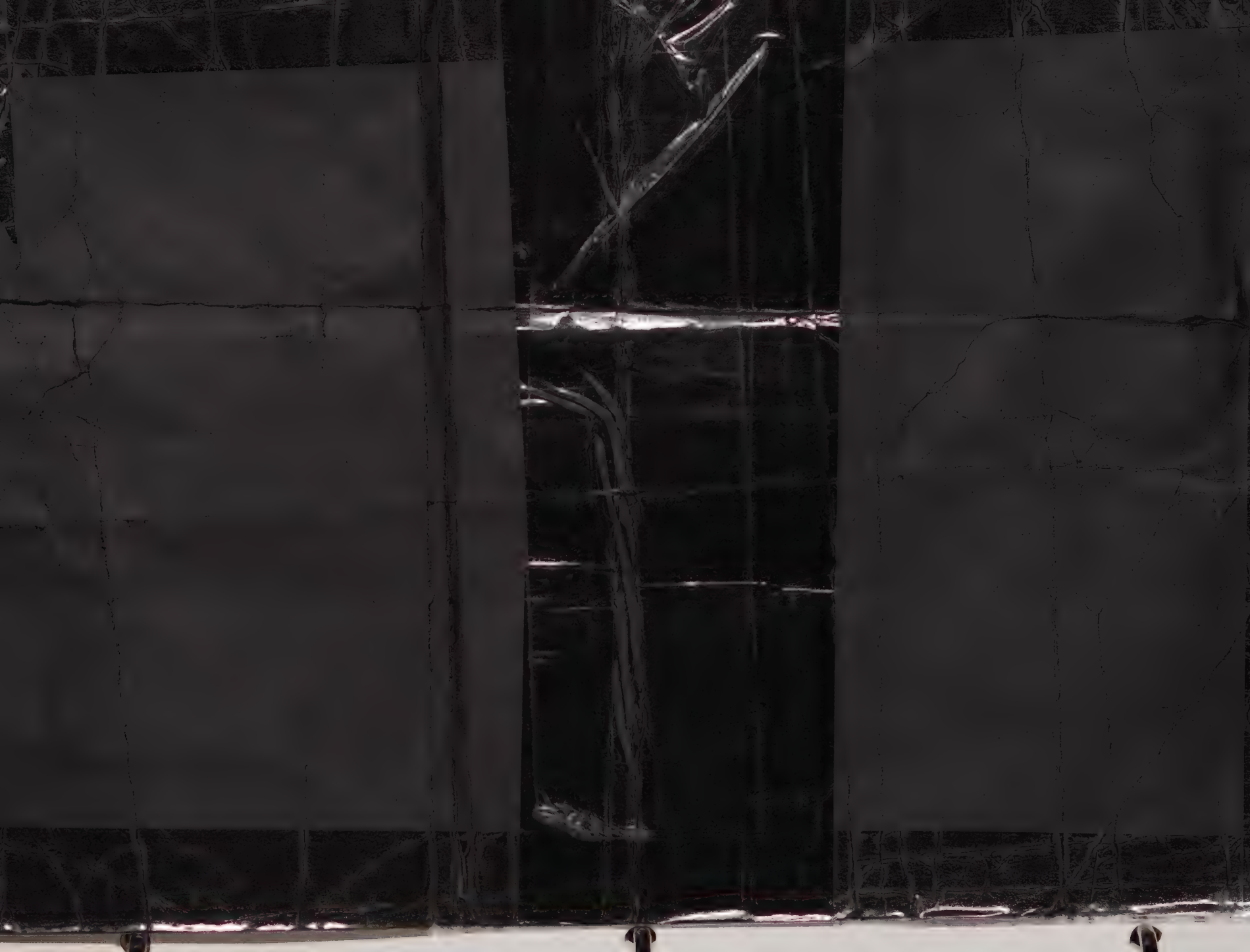
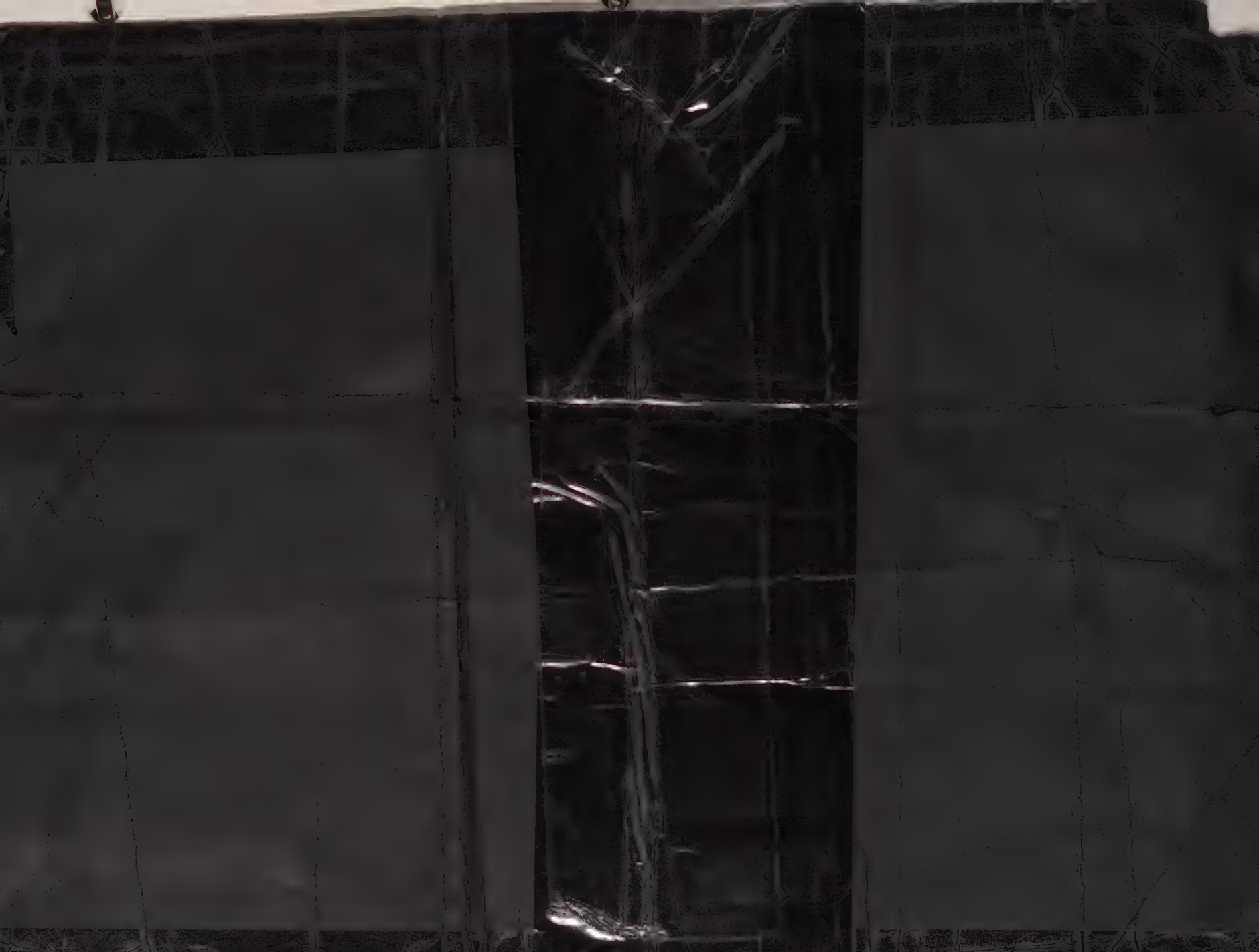
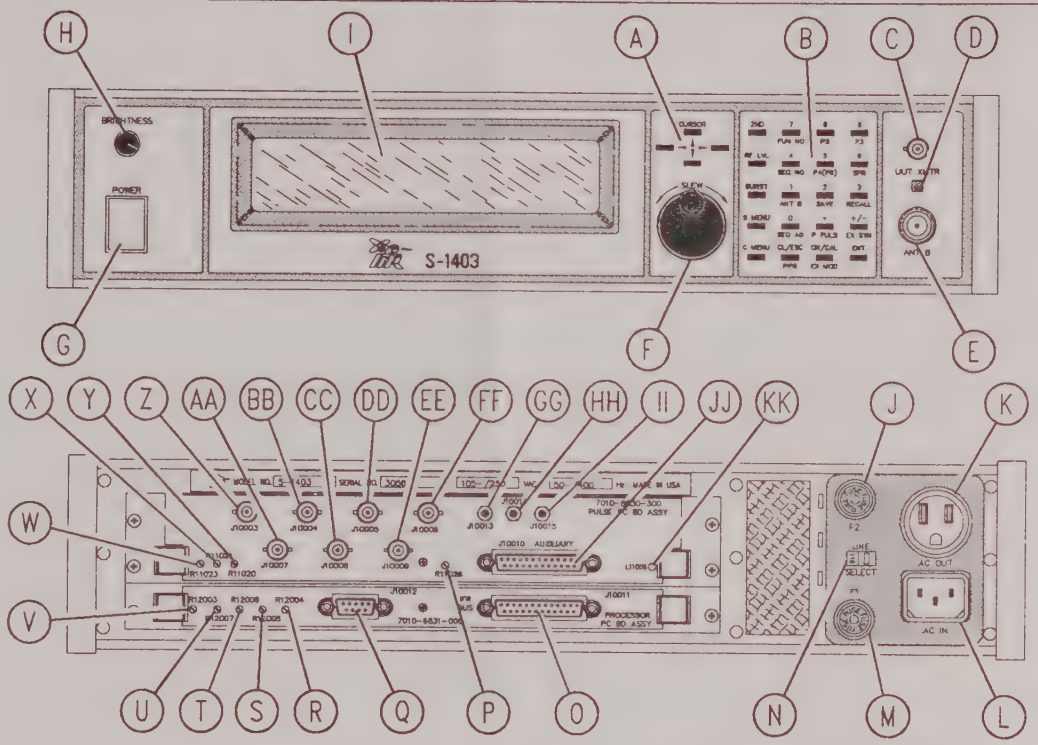
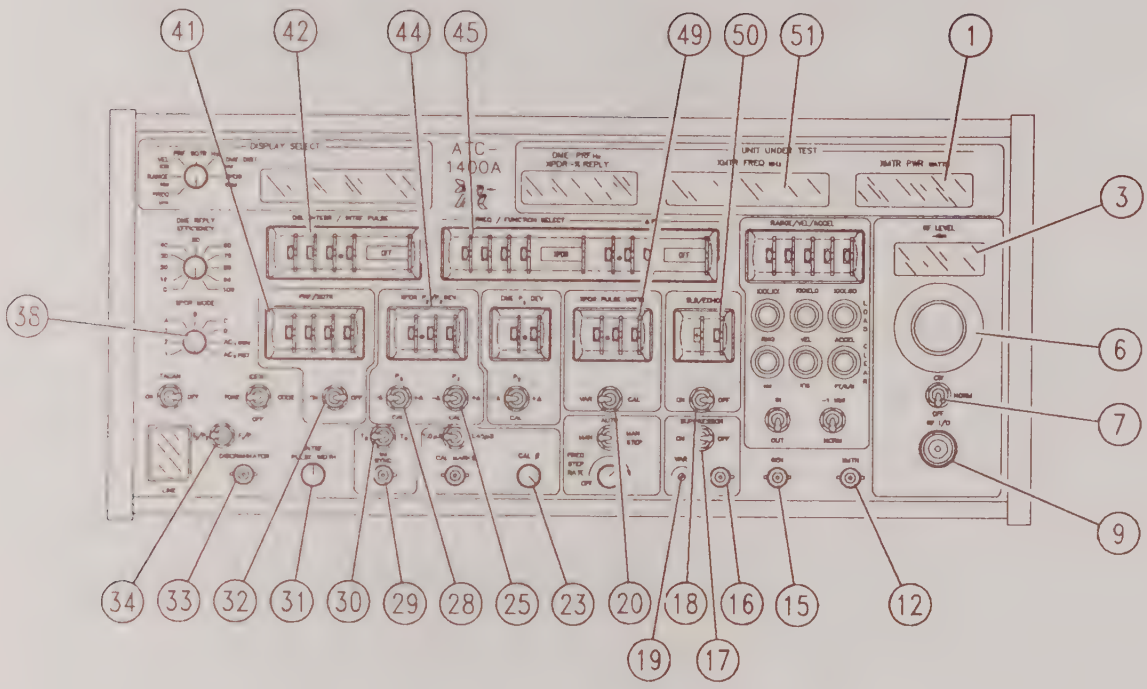




2. DESCRIPTION OF CONTROLS, CONNECTORS AND INDICATORS



A. CURSOR Keys
B. KEYBOARD
C. UUT XMTR Connector (J10001)
D. UUT XMTR Indicator
E. ANT B Connector (J10002)
F. SLEW Control
G. POWER Switch
H. BRIGHTNESS Control
I. MENU Display
J. F_2 Fuse
K. AC OUT Connector
L. AC IN Connector
M. F1 Fuse
N. LINE SELECT Switch
O. IFR BUS Connector (J10011)
P. DPSK AMPLITUDE BALANCE Adjust (R11026)
Q. TEST Connector (J10012)
R. R12004
S. R12005
T. R12006
U. SPR TIMING Adjust (R12007)
V. R12003
W. Zero Scale Adjust (R11023)
X. Full Scale Adjust (R11021)
Y. REF VOLTAGE Adjust (R11020)
Z. EXT MOD IN Connector (J10003)
AA. SCOPE TRIG OUT Connector (J10007)
BB. EXT SYNC IN Connector (J10004)
CC. EXT SYNC OUT Connector (J10008)
DD. MODE/ATCRBS S DISCRETE OUT Connector (J10005)
EE. PREPULSE OUT Connector (J10009)
FF. ANT B VIDEO (J10006)
GG. RF VERNIER OUT Connector (J10013)
HH. MEASUREMENT GATE OUT Connector (J10014)
II. DPSK OUT Connector (J10015)
JJ. AUXILIARY Connector (J10010)
KK. 80 MHz ADJUST (L11006)



1. XMTR PWR WATTS Display
3. RF LEVEL -dBm Display
6. RF LEVEL Control
7. CW/NORM/OFF Switch
9. RF I/O Connector
12. XMTR Connector
15. GEN Connector
16. SUPPRESSOR OUTPUT Connector
17. SUPPRESSOR ON/OFF Switch
18. SLS/ECHO ON/OFF Switch
19. SUPPRESSOR VAR Adjustment
20. XPDR PULSE WIDTH VAR/CAL Switch
23. CAL Ø Control
25. XPDR DEV P3/CAL Switch
28. XPDR DEV P2/CAL Switch
29. SYNC Connector
30. TO/TAC/TD Switch
31. INTERF PULSE WIDTH Control
32. PRF/SQTR ON/OFF Switch
33. DISCRIMATOR Connector
34. F2/P2 F1/P1 Switch
38. XPDR MODE Control
41. PRF SQTR Thumbwheels
42. DBL/INTERR/INTERF PULSE Thumbwheels
44. XPDR P2/P3 DEV Thumbwheels
45. FREQ/FUNCTION SELECT Thumbwheels
49. XPDR PULSE WIDTH Thumbwheels
50. SLS/ECHO Thumbwheels
51. XMTR FREQ MHz Display

Mode S System Front and Rear Panels
Figure 2

A. S-1403 Front and Rear Panel Description of Controls, Connectors and Indicators

The S-1403 Keyboard was designed to control the Menu display, eliminating the need for Thumbwheel Switches, Rotary knobs and resolvers for changing data values. The I/O Connector Pinout Tables are provided in Appendix A.

ITEM	NAME	DESCRIPTION

A. CURSOR Keys (Up, Down, Left, Right)

These keys are used to select a data or control field for editing. After positioning the cursor at the desired field, the entire field can be changed one character at a time for both decimal and octal data.

B. KEYBOARD

Used for data entry and control of the microprocessor. A keyboard entry changes the character at the position of the cursor and advances the cursor to the next character or field location. Decimal fields require all digits be changed. Octal fields allow changing of only 1 digit while leaving others unchanged.

C. UUT XMTR Connector

RF pulses transmitted by the UUT's ANT B Connector are detected in the S-1403. The resultant detected video is presented at this connector.

D. UUT XMTR Indicator

Illuminates when transmitter replies are received on ANT B.

E. ANT B Connector

Provides a second RF channel at a fixed power level for diversity testing.

F. SLEW Control

Used for command or data selection by rotating in either a cw or ccw direction. If several mnemonics can be selected in one field, use the SLEW Control for field selection. Octal data fields can be changed with the SLEW Control, but only one character at a time. The SLEW input allows the operator to rapidly advance to the desired function or data by bypassing all intermediate steps.

ITEM	NAME	DESCRIPTION

The SLEW Control changes only the value of the data characters or digits within the data or control fields indicated by the cursor.

G. POWER Switch

Applies AC power to the S-1403 Test Auxiliary and AC OUT Connector (K).

H. BRIGHTNESS Control

Controls the brightness of the MENU Display's backlighting. Clockwise rotation of control increases brightness, while counter-clockwise rotation of control decreases brightness.

I. Menu Display

Displays the appropriate menu as selected. Refer to Para. 2C(1) for a complete description of Control Menu #1, Para. 2C(2) for a complete description of Control Menu #2 and Para. 2C(3) for a complete description of the Sequence Menu.

J. F2 Fuse

Fuses power to the S-1403. When LINE SELECT Switch (N) is in the 115 VAC position, F2 should be 1.0 amp fast blow. When LINE SELECT Switch (N) is in the 230 VAC position, F2 should be a 0.50 amp fast blow.

K. AC OUT Connector

Convenience outlet used to power the ATC-1400A.

L. AC IN Connector

Power receptacle for applying either 115 VAC or 230 VAC single phase power to the S-1403. LINE SELECT Switch (N) must be set to the correct position before applying power.

M. F1 Fuse

Fuses the power to the S-1403 and the AC OUT Connector (K). F1 should be a 3.0 amp fast blow.

N. LINE SELECT Switch

Selects the line voltage that is applied to the S-1403.

ITEM	NAME	DESCRIPTION
O.	IFR BUS Connector (J10011)	Connects the S-1403 to the ATC-1400A to allow information exchange between the two units.
P.	DPSK AMPLITUDE BALANCE ADJUST (R11026)	USED ONLY DURING TEST SET CALIBRATION.
Q.	TEST Connector (J10012)	For IFR Systems Inc. use only.
R.	R12004	NOT USED.
S.	R12005	NOT USED.
T.	R12006	NOT USED.
U.	SPR TIMING ADJUST (R12007)	USED ONLY DURING TEST SET CALIBRATION.
V.	R12003	NOT USED.
W.	Zero Scale Adjust (R11023)	USED ONLY DURING TEST SET CALIBRATION.
X.	Full Scale Adjust (R11021)	USED ONLY DURING TEST SET CALIBRATION.
Y.	REF VOLTAGE Adjust (R11020)	NOT USED.
Z.	EXT MOD IN Connector (J10003)	When enabled from the S-1403 front panel or GPIB, the input from an external modulation source replaces the internal S-1403 pulse modulation.

ITEM	NAME	DESCRIPTION

AA. SCOPE TRIG OUT Connector (J10007)

Provides a trigger, controlled by T_O/TAC/T_D Switch (30), for time of interrogation and time of reply.

BB. EXT SYNC IN Connector (J10004)

When enabled from the S-1403 front panel or GPIB, allows SYNC from an external source.

CC. EXT SYNC OUT Connector (J10008)

Provides the sync for a second Mode S Test Set where not only diversity, but diversity with level control is required. Also, a time delay from one antenna to the other may be selected.

DD. MODE S/ATCRBS DISCRETE OUT Connector (J10005)

Provides a negative going 3.0 µs pulse whose leading edge occurs 1.0 µs prior to the Prepulse output leading edge, when an ATCRBS interrogation is pending. This is active for all functions except ATC and DI.

EE. PREPULSE OUT Connector (J10009)

Provides a programmable TTL output pulse whose leading edge occurs from 0 to 260 µs prior to the leading edge of P1 pulse.

FF. ANT B VIDEO OUT Connector (J10006)

Allows digital version of ANT B signal to be viewed simultaneously with the analog signal from ANT B Connector (E).

GG. RF VERNIER OUT Connector (J10013)

An Analog Output Signal is presented at this connector which provides a vernier control over the ATC-1400A RF output level.

HH. MEASUREMENT GATE OUT Connector (J10014)

A framing pulse is presented at this connector allowing pulse selection in the Mode S Reply or ATCRBS Reply for UUT power measurement and frequency measurement. Power measurement is displayed on XMTR PWR WATTS Display (1). Frequency measurement is displayed on XMTR FREQ MHz Display (51).

ITEM NAME DESCRIPTION

II. DPSK OUT Connector (J10015)

Provides a bi-polar level signal which drives the phase modulator in the ATC-1400A to provide DPSK Modulation. (DPSK Modulation is the format for the method of encoding data to the Mode S Transponder.)

JJ. AUXILIARY Connector (J10010)

Connects the S-1403 to the ATC-1400A to provide discrete signal interconnect.

KK. 80 MHz Adjust (L11006)

USED ONLY DURING TEST SET CALIBRATION.

B. Keyboard Definition

The S-1403 keyboard consists of 24 keys, which allow data entry into the microprocessor to select test functions, menu formats or field data for the selected menu. Most keys have a dual function which can select either a first order function or second order function. The "2nd" key must be pressed before any second order function can be selected. Cursor keys are located adjacent to the keyboard to expedite entering data.

FIRST ORDER KEYS				SECOND ORDER KEYS		
2nd	7	8	9	FUN#	P2	P3
RFLvl	4	5	6	SEQ#	P4(P6)	SPR
Burst	1	2	3	AntB	Save	Recall
SMenu	0	"."	±	SeqAd	PPuls	Exsyn
CMenu	CL/ESC	ON/CAL	ENT	PPG	ExMod	

Figure 3 - Data Entry and Function Keys

Data Entry Keys (0 to 9 and ".")

These keys are used to enter data values to the data and control fields. They are the Standard Numerical Value keys (i.e., 0 thru 9 and ".").

KEY(S)	DESCRIPTION

2nd 1 (Ant B)

This key sequence moves the cursor to the Ant B field and allows the value to be changed. Control Menu #1 is displayed.

2nd 7 (FUN#) n

Depressing the keys in this sequence will advance the function to the # selected and position the cursor in the function field.

2nd 8 (P2)

This key sequence moves the cursor to the P2 field and allows the value to be changed. Control Menu #1 is displayed.

2nd 9 (P3)

This key sequence moves the cursor to the P3 field and allows the value to be changed. Control Menu #1 is displayed.

2nd 2 (Save) n

This key sequence saves the present test setup in one of two non-volatile memory locations. All information from both Control menus and all the items of the Sequence menu are saved.

2nd 3 (Recall) n

This key sequence recalls one of two saved test setups. Upon recall, all functions are executed to assure the system operation was updated with the new menus. After recalling the "PAGE", Control Menu #1 is displayed.

2nd (PPuls)

This key sequence moves the cursor to the Prepulse Control field in Control Menu #2. Control Menu #2 is displayed.

2nd +/- (ExSyn)

This key sequence moves the cursor to the Ext. Sync. Out field in Control Menu #2. Control Menu #2 is displayed.

KEY(S)	DESCRIPTION

2nd ESC (PPG)

This key sequence moves the cursor to the Pulse Power Gate field in Control Menu #2. Control Menu #2 is displayed.

2nd Function Key

Pressing the 2nd function key conditions the processor to accept a second order function. This key must be pressed before selecting any function labeled on the lower part of the key.

RFLvl

Pressing this key moves the cursor to the corresponding menu field, which allows data to be entered directly through the keyboard or by rotating the SLEW Control. If the current menu is not CONTROL MENU #1, the display is switched to #1.

Burst

This key activates the Burst function. ATC, ACS, ACL or SEQ functions are used with the burst function (ie., pressing BURST Key activates interrogations of the selected function for the selected number of repetitions). The PRF rate is programmed by PRF/SQTR Thumbwheels (41).

NOTE: In the SEQ function, each Burst count represents one sequence item.

S Menu,

Pressing this key displays the Sequence menu starting with the number last displayed (default is 1).

+/-

This key displays a plus or minus sign for decimal data. It changes the decimal value from plus to minus or vice versa.

NOTE: The +/- key when used, must follow data entry.

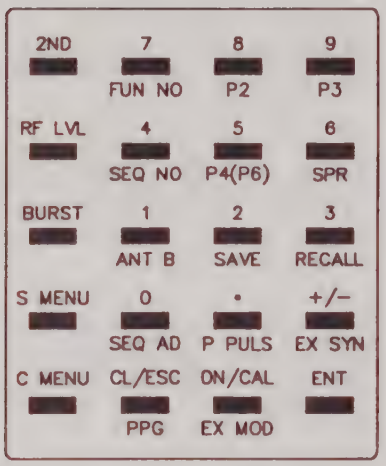


Figure 4 - S-1403 Keypad

KEY(S) DESCRIPTION

C Menu

Depressing the C Menu key followed by either a one (1) or a two (2) displays the desired Control menu.

CL/ESC Key

This key terminates a function or data key input sequence prior to its normal completion and returns the field value to its previous state. The ESC key resets the data or command field to the value it contained before it was changed. For Octal fields, this key will reset the entire field to zero rather than replacing the data changed with the previous data.

ON/CAL

Used to set various values for rapid change of condition. The following field conditions can be selected:

ON/OFF
CAL/OFF/VAR
OFF/(Value last selected)
CAL/VAR

ENT

Causes a normal termination of an input sequence.

2nd 4 (SEQ#) nn ENT

This key sequence displays the Sequence menu starting at sequence #nn.

KEY(S)	DESCRIPTION

2nd 5 (P4[P6])

This key sequence moves the cursor to the P4/P6 field and allows the value to be changed. Control Menu #1 is displayed.

2nd 6 (SPR)

This key sequence moves the cursor to the SPR (Sync Phase Reversal field and allows the value to be changed. Control Menu #1 is displayed.

2nd ON/CAL (Ex Mod)

This key sequence moves the cursor to the Ext.Mod.In. field in Control Menu #2 and allows the value to be changed. Control Menu #2 is displayed.

2nd 0 (Seq Ad)

This key sequence moves the cursor to the sequence item uplink format address field in the current Sequence menu and allows the value to be changed. The Current Sequence menu is displayed.

C. Display Menu Definition

(1) Control Menu Format #1

FIELD	DESCRIPTION

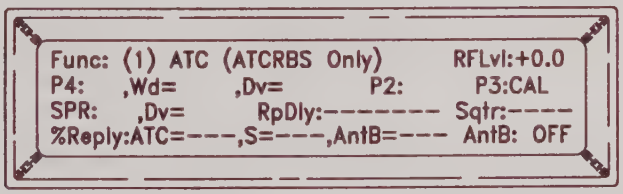


Figure 5 - Sample Control Menu #1

FIELD DESCRIPTION

Func: (Function) Field

The desired function, as shown below, is displayed depending on the keyboard selection:

KEYBOARD SELECTION	FUNCTION
FUNC: (1)	ATC (ATCRBS Only)
FUNC: (2)	SEQ (Mode S Only)
FUNC: (3)	ACS (ATCRBS only All-Call)
FUNC: (4)	ACL (ATCRBS/Mode S All-Call)
FUNC: (5)	INTLCE (Ratio 1:[1 - 999]); (Mode S to ATCRBS)
FUNC: (6)	DI, 1st = ___, 2nd = ___, (ATC,ACS, ACL or SEQ for both)
FUNC: (7)	BURST (ATC/ACS/ACL/SEQ), and 1 to 999

(Error Message) Field

One of four ERROR messages can be displayed in this field.

Error Message List

AP Error: Indicates an error in the Address parity field of one of the sequence items. The AP Error message is displayed until the next downlink is received.

Recall Error: This message occurs if a recall command is performed for a recall buffer that has not had information previously saved. The recall error message is displayed until another key is depressed on the front panel.

DI/INTF Error: DBL INTERR/INTRF PULSE (DI/INTRF) Thumbwheels (42) selections are monitored by the S-1403. The DOUBLE position is valid only when S-1403 is in DI function. If one test set of the Mode S Test System (either S-1403 or ATC-1400A) is set for Double Interrogation while the other test set is set a different function this error message will appear.

FIELD	DESCRIPTION
RATE Error:	This error message occurs when the PRF set by the PRF/SQTR Thumbwheels (41) are set to a rate larger than the S-1403 can operate. Limitations are defined in Table 1, Section 1-3-1, Specifications.

RFLvl Field

Displays an RF Level Vernier of up to ±3.0 dB.

Pulse Control Field (P4/P6)

This field controls P4 for the All-Call Functions, ACS and ACL, and P6 for the Mode S function SEQ.

Fields not used for a particular function are left blank. Fields used, but not currently being updated, are filled with dashes.

P_4/P_6:	CAL/VAR/OFF (Level Control or Disable)

NOTE: The second character changes from a four to a six, depending on the function selection:

P_4 Wd:	CAL/-0.2 to 3.55 µs in 0.05 µs steps.
P_6 Dv:	CAL/±1.95 µs in 0.05 µs steps CAL/VAR/OFF (Level control or Disable)
P_4 Dv:	CAL/±1.95 µs in 0.05 µs steps CAL/VAR/OFF (Level control or Disable)

SPR (SYNC Phase Reversal), RpDly (Reply Delay) and Sqtr (Squitter) Fields

SPR:	ON/OFF (Enable or Disable)
SPR DV:	CAL/±1.00 µs in 0.05 µs steps (Deviation)
RpDly:	000.000 to 399.000 (Read only)
Sqtr:	0.00 to 9.99; outside of range, dashes "–" are displayed.

FIELD DESCRIPTION

% Reply Field

ATC =0 to 127
S =0 to 127
ANT B=0 to 127

For all functions, the operator should refer to DISPLAY (I) for valid % Reply information. A Mode S % Reply is determined by a valid four pulse preamble. All other replies are assumed to be ATCRBS including non-valid replies. ANT B is a composite %Reply consisting of valid Mode S, ATCRBS plus any invalid replies. Squitter replies are not included in any %Reply displays.

Ant B Field

Enables/disables diversity and allows programming of the delay for ANT B from 0 to ±0.95 µs in 0.05 µs steps. The set value remains in memory when the channel is disabled by the ON/CAL key. Upon re-enabling, the previously programmed value is restored.

(2) Control Menu #2:

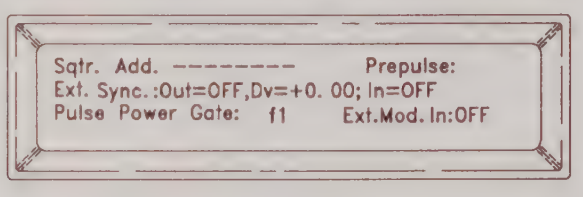


Figure 6 Sample Control Menu #2

Sqtr. Add. (Squitter Address) Field

24-bit octal value (read only)

Prepulse Field

0 thru 260 µs (in 1.0 µs Steps)/OFF

Ext. Sync. (External Synchronous) Field

Out = ON/OFF
Dv = -9.95 µs to 9.95 µs (in 0.05 µs steps)
In = ON/OFF

FIELD DESCRIPTION

Pulse Power Gate (Selected Pulse) Field

The reply delay is used to determine where to measure PPMG Pulse. This allows correct PPMG positioning in ACS and ACL Test Functions independent of P_4.

For all reply pulses, the measurement gate must be enabled prior to the rising edge of the pulse to be measured. The measurement will continue until the next falling edge of the reply. In the case of Mode S replies, since they are in PPM format, care should be taken to ensure the data pulses prior to and following the pulse to be measured are in such a state that their power levels will not be measured as well. For example: to measure P_6 power: If P_6 is "0", P_5's state doesn't matter and P_7 should be a "0". If P_6 is a "1", then P_5 should be "1" and P_7's state doesn't matter. If P_5 were "0" and P_6 a "1", no rising edge would be detected and therefore the power reading would be zero.

For the S-1403 to control pulse power measurement, F_2/P_2-F_1/P_1 Switch (34) must be in the F_2/P_2 position. The F_1/P_1 position will measure the pulse power of an ATCRBS F_1 reply pulse only.

DATA KEY OR SLEW ENTRY	PULSE	DATA KEY OR SLEW ENTRY	PULSE
ON/CAL	OFF	9	b1
1	f1	10	d1
2	c1	11	b2
3	a1	12	d2
4	c2	13	b4
5	a2	14	d4
6	c4	15	f2
7	a4	16	spi
8	X		
MODE S: P1 through P116 pulses are selectable by SLEW Control (F) or pulse number using the DATA Entry Keys.			
NOTE: Pulse Power Measurement is performed by the ATC-1400A and displayed on XMTR PWR WATTS Display (1).			

Pulse Power Mnemonics
Table 1

(3) Sequence Menu Format (Scrolled)

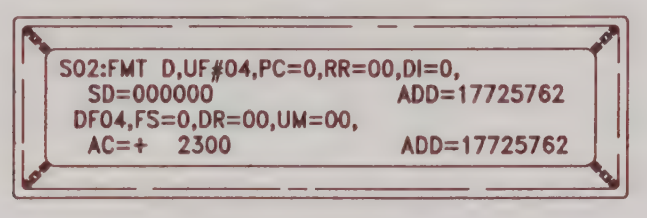


Figure 7 Sample Sequence Menu Format

FIELD DESCRIPTION

Sequence Number (S01 through S16) Field:

The Sequence Number (01 through 16) can be selected or displayed by selecting the Sequence menu (S menu) and entering the number using the DATA Entry Keys, or by slewing to the desired number with the SLEW Control. An alternate method is to first select the sequence number, then press the "2nd", "4", "nn" and "ENT" keys (where "nn" is the sequence number from 01 to 16). Refer to Appendix E for a description of default menus 01 through 08.

The default condition upon power-up has all currently defined (RTCA DO-181; March, 1983) Uplink/ Downlink formats assigned to sequence numbers 1 through 8. Definitions of these formats are listed in Appendix B, Tables B-1 and B-2. The remaining Sequence Numbers are set "OFF" to disallow any transmission. Sequences are turned OFF/ON by positioning the cursor key in the sequence number field and pressing the ON/CAL key.

FMT (Format) Field

"L", "S", "D" selected by Slew Control or ON/CAL Key.FMT "S" is user definable in Octal data for short (56 bit) words. FMT "L" is user definable for long (112 bit) words. FMT "D" is defined formats 0-23 according to Table B-1.

UF (Uplink Format) Field

Uplink Format Numbers (00 through 31) are selected by the SLEW Control or data entry keys. This field is accessed via the cursor control keys.

FIELD	DESCRIPTION

DATA Fields

Following the Format Number is one or more formatted Long or Short Data Fields which contain information as defined in Appendix E. The "Add" field data is converted to the required address and parity (AP) field data before transmission.

NOTE: Any undesignated bits in the Data Fields are set to zero.

DF (Downlink Format) Field

Downlink Format Numbers (0 through 31) are read only fields that display the Downlink information received from the transponder. Downlink Formats are defined in Table B-2; the Format Fields are defined in Appendix E.

D. ATC-1400A Front and Rear Panels Control and Connectors

The following ATC-1400A controls and connectors are utilized with the Mode S Test System. Those controls and connectors not directly involved with testing Mode S transponders are not listed. Descriptions listed below supersede descriptions listed in the ATC-1400A Operation/Maintenance Manual.

ITEM	NAME	DESCRIPTION

1. XMTR PWR WATTS Display

   Provides a continuous visual display of peak pulse power of the UUT.

3. RF LEVEL -dBm Display

   Displays the programmed peak RF power of the generator in dB below 1 mW.

6. RF LEVEL Control

   Adjusts RF generator level in 1 dB steps by slowly turning control knob.

ITEM	NAME	DESCRIPTION

7. CW/NORM/OFF Switch

CW - Supplies a continuous-wave signal, which provides a convenient output for test and calibration of the ATC-1400A.

NORM - Allows ATC-1400A to operate in normal mode.

OFF - Inhibits all pulses the ATC-1400A is capable of generating.

9. RF I/O Connector

Connects all interrogation and reply RF pulses to the antenna connector of the UUT (ANT A).

12. XMTR Connector

RF pulses transmitted by UUT are detected by the ATC-1400A and presented at this connector.

15. GEN Connector

RF output pulses from generator are detected and presented at this connector, to enable viewing transponder interrogations and interference pulses.

16. SUPPRESSOR OUTPUT Connector

Mutual suppression pulses are provided at this connector.

17. SUPPRESSOR ON/OFF Switch

Enables/disables mutual suppression pulses.

18. SLS/ECHO ON/OFF Switch

ON - Disables all other pulse amplitude control and enables the SLS pulse.

19. SUPPRESSOR VAR Adjustment

Level of the suppression pulse can be adjusted from +3 to 27 V by this control. Clockwise rotation increases level and counterclockwise rotation decreases level of suppression pulse.

ITEM	NAME	DESCRIPTION

20. XPDR PULSE WIDTH VAR/CAL Switch

VAR - Selects a variable pulse width (as read from XPDR PULSE WIDTH Thumbwheels [49]) from 0.15 µs to 1.95 µs, in 0.05 µs increments.

NOTE: Generator output level is not specified below 0.2 µs pulse width.

CAL - Selects a transponder pulse width of 0.8 µs.

21. FREQ STEP RATE Control

The rate the channel frequency is incremented automatically is determined by the position of this control. Position must be OFF (fully CCW) when testing Mode S.

22. MAN/AUTO/MAN STEP Switch

MAN - Position required for Mode S testing.

AUTO - Channel frequency is incremented automatically in 1 MHz steps.

MAN STEP - Channel frequency can be incremented manually in 1 MHz steps.

23. CAL Ø Control

Adjusts the phase of timing calibration pulses with respect to interrogation pulses. Clockwise rotation delays timing pulses and enables the operator to align leading edge of timing pulses with F_1 of reply.

ITEM	NAME	DESCRIPTION

25. XPDR DEV P_3/CAL Switch

-Δ - Advances position of P_3 pulse from nominal, by value selected on XPDR P_2/P_3 DEV Thumbwheels (44) in microseconds.

CAL - P_3 pulse remains in nominal position. XPDR P_2/P_3 DEV Thumbwheels (44) have no effect on deviating P_3 pulses.

+Δ - Delays position of P_3 pulse from nominal, by value selected on XPDR P_2/P_3 DEV Thumbwheels (44) in microseconds.

28. XPDR DEV P_2/CAL Switch

-Δ - Advances position of the P_2 pulse from nominal, by value selected on the XPDR P_2/P_3 DEV Thumbwheels (44) in microseconds.

CAL - P_2 pulse remains in nominal position. XPDR P_2/P_3 DEV Thumbwheels have no effect on deviating P_3 pulses.

+Δ - Delays position of the P_2 pulse from nominal, by value selected on the XPDR P_2/P_3 DEV Thumbwheels (44) in microseconds.

29. SYNC Connector

A negative oscilloscope sync pulse generated by test set is presented at this connector. Signal output is controlled by T_O/TAC/T_D Switch.

30. T_O/TAC/T_D Switch

Sync selection control allowing the operator to sync on the interrogation, reply, or 1st or 2nd interrogation and reply sequence.

31. INTERF PULSE WIDTH Control

Width of interference pulse is adjusted from 0.2 μs to 5 μs by this control. Clockwise rotation increases width of pulse.

32. PRF/SQTR ON/OFF Switch

Two-position toggle switch which when set to OFF, will inhibit interrogations.

ITEM	NAME	DESCRIPTION

33. DISCRIMINATOR Connector

The instantaneous frequency of the RF input pulses are discriminated and made available at this connector. The frequency modulation of the transmitter under test can be monitored within one pulse or between two pulses. The discriminator produces noise when no RF is present.

34. F_2/P_2 F_1/P_1 Switch

Must be in F_2/P_2 position to enable PPMG measurements.

38. XPDR MODE Control

Selects nominal P_3 pulse position of transponder interrogations.

41. PRF/SQTR Thumbwheels

Selects the interrogation rate in Hz.

42. DBL/INTERR/INTERF PULSE Thumbwheels

Interference modes select interference pulse position from P1 in microseconds. DOUBLE selects double interrogation spacing when S-1403 is in DI function. DI/INTRF ERROR will display on MENU Display (I) whenever either DOUBLE is selected and S-1403 is not in DI Test Function or INTERR is selected and S-1403 is not in DI Test Function.

44. XPDR P_2/P_3 DEV Thumbwheels

Position of the P_2 or P_3 pulse can be deviated from the nominal position by value selected on the thumbwheel switches in microseconds.

45. FREQ/FUNCTION SELECT Thumbwheels

Select transponder or DME mode of operation and frequency of test set.

49. XPDR PULSE WIDTH Thumbwheels

Width of the P_1, P_2 and P_3 pulse can be varied by the value selected on thumbwheel switches in microseconds.

ITEM	NAME	DESCRIPTION

50. SLS/ECHO Thumbwheels

Range is -19 to +9 dB.

Selects amplitude of sidelobe suppression pulse and interference pulse in dB, above nominal RF level.

51. XMTR FREQ MHz Display

Average frequency of UUT's RF pulses are measured between 50% amplitude point and are displayed continuously.

53. GPIB Connector

24-pin female connector conforming to IEEE standard 488-1978 for interface of general purpose programmable instrumentation.

54. GPIB ADDRESS Dip Switches

Eight segment DIP switch used for setting IEEE-488 bus address for remote control mode of operation.

71. IFR BUS Connector (J5)

25-pin female connector for communications between ATC-1400A and IFR BUS Connector (J10011) to allow information exchange within the Mode S Test System.

72. AUXILIARY Connector (J6)

25-pin female connector for providing discrete signal interrconnect between the Mode S Test System when connected to AUXILIARY Connector (J10010).

73. DPSK INPUT Connector (J1)

Receives a bi-polar signal which drives the internal phase shift circuit to provide DPSK Modulation (DPSK Modulation is the format for the method of encoding data to the Mode S transponder). This connector is required to be connected to DPSK OUT Connector (J10015).

ITEM	NAME	DESCRIPTION

75. External Measurement Gate Connector (J3)

Allows pulses other than F_2/P_2 and F_1/P_1 to be measured when connected to MEASUREMENT GATE OUT Connector (J10014). A framing pulse is presented at this connector which allows pulse selection in the Mode S reply or ATCRBS reply for UUT power and frequency measurements. Power measurement is displayed on XMTR PWR WATTS Display (2). Frequency measurement is displayed on XMTR FREQ MHz Display (51).

76. RF LEVEL INPUT Connector (J4)

Additional ±3 dB level control of RF Output received from RF VERNIER OUT Connector (J10013). The signal presented at this connector provides a vernier control over RF output level.

3. GENERAL OPERATING PROCEDURES

The procedures contained within this section are instructions relating to Front Panel (LOCAL) operations used for the individual test functions. Specific UUT Test Procedures are addressed in the UUT Manuals.

For each operational function, special considerations are listed at the beginning of each section. In addition to the operational considerations, minor anomalies may appear during the operation of the system. Known anomalies are given as part of the operational considerations directing the user to refer to Appendix F, System Anomalies.

REMOTE CONTROL (GPIB) OPERATION

Remote communication with the Mode S Test System is provided by use of the General Purpose Interface Bus (GPIB) which conforms to IEEE Standard 488-1978. All communication with the Mode S Test System over the GPIB is implemented with ASCII encoded character strings. Refer to Section 1-2-4 for a complete description of GPIB operation.

LOCAL (FRONT PANEL) OPERATION

The Mode S Test System, consisting of the S-1403 Test Auxiliary interfaced with the ATC-1400A Transponder/DME Test Set, provides supplementary transponder pulse functions for the purpose of simulating an ATCRBS/Mode S equipped SSR (Secondary Surveillance Radar) ground station.

To operate, set ATC-1400A Controls as follows:

	ATC-1400A Control	Setting
7	CW/NORM/OFF Switch	NORM
18	SLS/ECHO ON/OFF Switch	OFF
21	FREQ STEP RATE Control	OFF
22	MAN/AUTO/MAN STEP Switch	MAN
25	XPDR DEV P3/CAL Switch	CAL
28	XPDR DEV P2/CAL Switch	CAL
32	PRF/SQTR ON/OFF Switch	ON
37	TACAN ON/OFF Switch	OFF
38	XPDR MODE Control	A
40	DISPLAY SELECT Control	PRF SQTR Hz
41	PRF/SQUITTER Thumbwheels	0200
42	DBL INTERR/INTERF Thumbwheels	000.0 OFF
45	FREQ/FUNCTION SELECT Thumbwheels	1030 XPDR
48	ΔF Thumbwheels	OFF
52	RANGE/VEL/ACCEL Thumbwheels	00000
66	SELF INTERROGATE ON/OFF Switch	OFF

SYSTEM CHARACTERISTICS

The Mode S Test System has seven (7) distinct functions of operation as listed below:

Paragraph	Test Function	Page No.
3-A	ATC Test Function	4
3-B	SEQ Test Function	12
3-C	ACS Test Function	28
3-D	ACL Test Function	38
3-E	INTLCE Test Function	52
3-F	DI Test Function	45
3-G	BURST Test Function	76

These functions allow the operator to simulate signal conditions for:

1. An ATCRBS environment (ATC Function) where an ATC ground station is transmitting a standard two-pulse interrogation and expecting either a Mode A or Mode C reply. The S-1403 has the additional capability to decode and display Mode S squitter replies, allowing the operator to determine the aircraft address.

2. A Mode S environment (SEQ Function) in which a ground based interrogator can transmit a number of uplink formats to the Mode S transponder and decode it's replies. Up to sixteen unique uplink formats may be programmed with their accompanying replies displayed on each of the S-1403 Sequence Menu displays.

3. An interlacing environment (INTLCE) in which both ATCRBS and Mode S interrogations are combined at a normal ratio of ten ATCRBS to one Mode S.

For these environmental simulations, the Mode S Test System provides control for all pulse parameters to test the limits of operation of the Unit Under Test (UUT). Indication of proper operation is provided by percent reply displays that discriminate between ATCRBS and Mode S replies. In addition to these common signal environment simulations, the Mode S Test System provides a means of testing both minimum interrogation spacing (DI Test Function) and rate limiting (BURST Test Function).

The All-Call Short (ACS) and All-Call Long (ACL) Test Functions provide a quick and convenient way to determine if the transponder is replying properly as either ATCRBS or Mode S. These functions provide full control over P_4 pulse characteristics to determine the proper response.

Diversity testing is possible in all functions by enabling ANT B. This tests the UUT's ability to switch antennas by simulating a disparity in amplitude or time from the ANT A to the ANT B output.

SPECIAL MODE S CONSIDERATIONS

Some Mode S operations utilizing the S-1403 to ATC-1400A are different from ATCRBS operations. A highlight of major differences are listed below:

1. DISPLAY SELECT Readout (43) is not valid for Mode S replies.

2. ANT A must be operational for ANT B to be operational.

3. Squitter display does not discriminate between dual antenna inputs.

4. RF adjustments utilizing SLEW Control (F) require as much as one minute to stabilize for low PRF transmissions. RF LEVEL Control (6) requires little or no stabilization time.

5. Squitter inputs are summed between ANT A and ANT B. Therefore, squitter period reads double when ANT B is turned OFF. Squitter transmissions from the UUT alternate between ANT A and ANT B outputs.

6. For %Reply:S=, only Mode S replies are decoded. All other replies to include invalid Mode S replies are assumed to be ATCRBS. A 32 µs measurement dead time occurs between the first ATCRBS reply pulse detected and the next attempt at reply pulse detection.

A. ATC Test Function

NOTE: The following three items highlight some special considerations for the ATC Test Function. Review these items and the anomalies for ATC Test Function listed in Appendix F prior to utilizing this test function.

Squitter delay alternates between ANT A and ANT B. When ANTB: field is OFF, squitter is measured only by ANT A.

Simultaneous squitter or replies to/from ANT A and ANT B will not be detected.

PRF rate is limited to 1500 with replies occurring or 850 without replies.

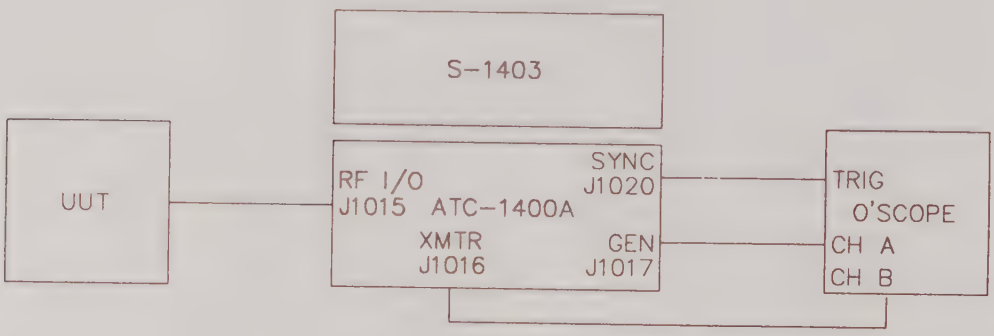


Figure 7 ATC Test Function Hook-up Diagram

(1) Description of ATC Test Function.

The ATC Test Function simulates an ATCRBS ground station standard two-pulse interrogation sequence (described in Appendix C, ATC-1400A Operation/Maintenance Manual). The ATC Test Function also measures characteristics of the reply sequence to verify proper operation of an ATCRBS transponder.

NOTE: S-1403 controls are identified by alphabetic character identifiers whereas all ATC-1400A controls are identified by numeric character identifiers.

The ATC Function is selected utilizing the key sequence "2nd, 7, 1", or by moving the cursor to the Function (Func:) control field, in Control Menu #1, and pressing key "1". S-1403 Control Menus #1 and #2, along with the ATC-1400A parameter selections listed in table 2, are now programmed or enabled.

PARAMETER	CONTROL
Interrogation Rate	PRF/SQTR Thumbwheels (41) PRF/SQTR ON/OFF Switch (32)
P_1 Pulse Width	XPDR PULSE WIDTH Thumbwheels (49) XPDR PULSE WIDTH VAR/CAL Switch (20)
P_2 (SLS) Level	SLS/ECHO Thumbwheels (50) SLS/ECHO ON/OFF Switch (18)
P_2 Deviation	XPDR P2/P_3 DEV Thumbwheels (44) XPDR DEV P_2/CAL Switch (28)
P_2 Pulse Width	XPDR PULSE WIDTH Thumbwheels (49) XPDR PULSE WIDTH VAR/CAL Switch (20)
P_3 Pulse Width	XPDR PULSE WIDTH Thumbwheels (49) XPDR PULSE WIDTH VAR/CAL Switch (20)
P_3 Deviation	XPDR P_2/P_3 DEV Thumbwheels (44) XPDR P_3/CAL Switch (25)
Frequency	FREQ/FUNCTION SELECT Thumbwheels (45)
Suppressor Pulse	SUPPRESSOR ON/OFF Switch (17)
Interference Pulse	DBL INTERR/INTERF PULSE Thumbwheels (42)
Mode Selection	XPDR MODE Control (38)

Table 2 - ATC -1400A ATC Test Function Active Controls

Replies to the Mode S Test system are monitored and displayed as shown in Table 3:

Function	S-1403	ATC-1400A
%Reply	X	
Reply Delay	X	
Squitter Period	X	
Squitter Address	X	
UUT Power		X
UUT Frequency		X
Generator PRF		X
ATCRBS XPDR Code	X	X
Mode S XPDR Code	X	X

Table 3 - Mode S Reply Displays

The S-1403 controls the P_3 level, the reply pulse selection for power measurement (f_1, f_2, or any pulse in between), control of an External Sync Output or Input, and the control of an External Modulation Input.

(2) Control Menu #1 Display Definition

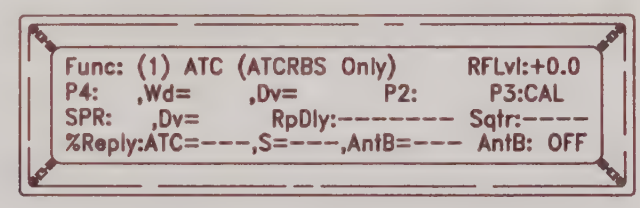


Figure 8 - ATC Test Function Control Menu #1

Func: (1) ATC (ATCRBS Only)
This operational mode measures the ATCRBS UUT reply delay and percent reply (ref. Para. 1-2-2, Table 1).

RFLvl:	Adjustments for RF Levels in 0.1 dB steps (within a range of ±3.0 dB). RF adjustments are in addition to the level shown in RF LEVEL -dBm Display (3). Adjustments of 1 dB or greater should be accomplished utilizing SLEW Control (6).
P_4:	Not active in ATC Test Function.
P_4:Wd=	Not active in ATC Test Function.
P_4:Dv=	Not Active in ATC Test Function.
P_2:	Not active in ATC Test Function.
P_3:	ATCRBS P_3 pulse level control selections: "CAL", "OFF" or "VAR". CAL selects the 0 dB reference level. OFF disables P_3 pulse. VAR enables level control from SLS/ECHO Thumbwheels (50) when the SLS/ECHO ON/OFF Switch (18) is OFF (i.e., P_2 is not enabled).
RpDly:	Displays the measured reply delay for ATCRBS (3.0 µs) interrogations with 25 ns resolution and 100 ns accuracy.
Sqtr:	Displays squitter period (transmission interval of DF=11 downlink format) from 0.0 to 9.99 sec with 10 ms resolution.
%Reply:ATC=	Displays percent of ATCRBS replies from 0 to 127% in 1% steps.
%Reply:S=	Displays percent of Mode S replies from 0 to 127% in 1% steps. During ATC Test Function, this field should display either dashes or remain blank.
%Reply:AntB=	Displays percent of replies received from ANT B Connector, from 0 to 127%, in 1% steps. If ANT B Connector (E) is not utilized, this field should display dashes or remain blank. AntB: field must be ON to receive data.

AntB: Enables (delay value) or disables (OFF) Channel B, the diversity generator. When enabled, a value from -0.95 to +0.95 µs can be selected in 0.05 µs steps as the delay from Channel A to Channel B.

(3) Control Menu #2 Display Definition

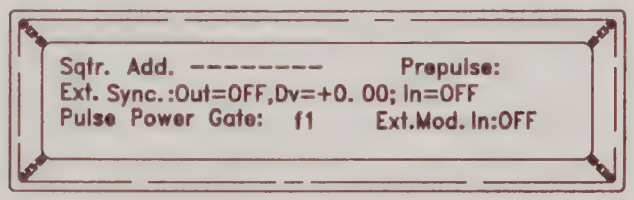


Figure 9 - ATC Test Function Control Menu #2

Sqtr. Add. 24-bit octal value decoded from an unsolicited ANT A reply/squitter. This value is the Mode S Transponder address and is transmitted via Downlink Format 11.

Prepulse: Not used in ATC Test Function.

Ext.Sync.:Out= ON/OFF control for external sync output function.

Ext.Sync.:Dv= Deviation control for external sync output. The range of input is from -9.95 µs to +9.95 µs in 50 ns steps.

Ext.Sync.:In= ON/OFF control for External Sync input control (positive TTL signal). Overrides EXT SYNC OUT.

Pulse Power Gate: Pulse Power Measurement Gate (select pulse) settings are selected by rotating the SLEW Control (F) or by selecting the pulse number from the sequence listed in Section 1-2-2, Table 1.

For all reply pulses, the measurement gate must be enabled prior to the rising edge of the pulse to be measured. The measurement will continue until the falling edge of the reply. The reply pulse to be measured must be enabled for the measurement to be valid.

The power measurement is performed by the ATC-1400A and displayed on XMTR PWR WATTS Display (1). The S-1403 controls pulse power measurement when F_2/P_2-F_1/P_1 Switch (34) is set to F_2/P_2. F_1/P_1 measures pulse power of an ATCRBS F_1 reply pulse only.

Ext.Mod.In: ON Disables the S-1403 internal pulse generator.
OFF Allows simultaneous internal and external modulation.

(4) Sequence Menu (Uplink/Downlink Format) Description.

ATC Test Function does not utilize sequence menus.

(5) Explanation of ATC Function Timing Diagram.

All timings specified are referenced to P_1 rising edge.

Internal timing is referenced to the SELF INTERROGATE (Pin 14, J10010) trailing edge for stability (17.95 µs delay time trailing edge to leading edge of P_1) for normal output. P_2 is output when SLS/ECHO ON/OFF Switch (18) is ON. When SLS/ECHO ON/OFF Switch (18) state changes, the S-1403 senses the change and provides the SLS Gate output at this time, allowing level control with SLS/ECHO Thumbwheels (50). Refer to Table 2 for P_2 and P_3 width and deviation controls.

When the UUT replies to the interrogation, ANT A (RF I/O Connector [9]) receives the RF signal, detects the video information, and returns the video signal to S-1403 J10010 pin 11. The S-1403 measures the reply delay time and displays the result on Control Menu #1 RpDly field. The power of each individual pulse may be measured by setting F_2/P_2-F_1/P_1 Switch (34) to F_2/P_2 and selecting the desired pulse, with SLEW Control (F), in Pulse Power Gate field of Control Menu #2. The measurement gate is then output to the ATC-1400A on MEASUREMENT GATE Connector (HH), J10014, and viewed on XMTR PWR WATTS Display (1).

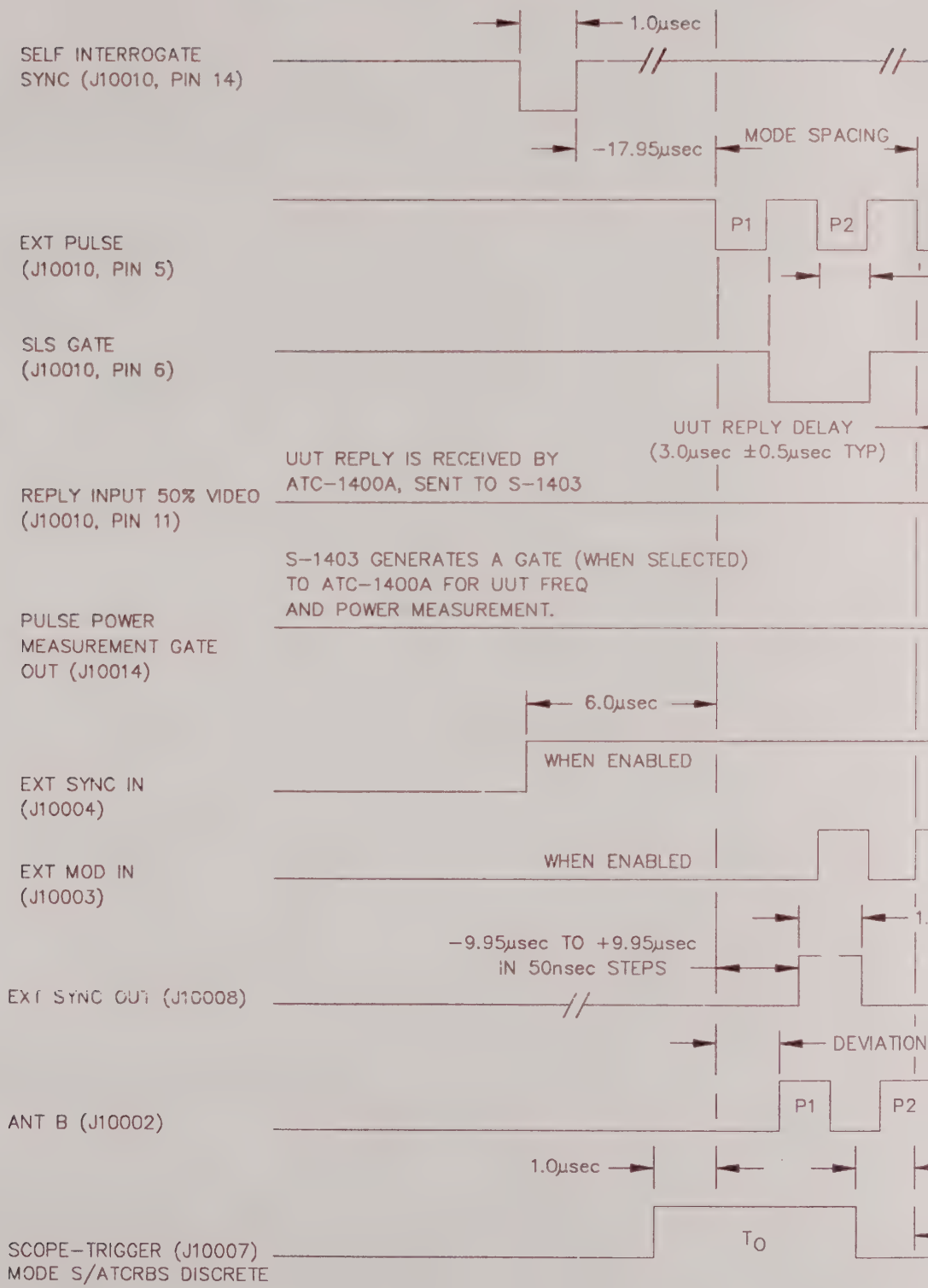
When EXT SYNC is desired, the operator must first select Ext.Sync.:In=ON and connect the external source to EXT SYNC OUT Connector (CC), J10008. The Ext pulse output rising edge sequence occurs 6.0 µs following the Sync Input.

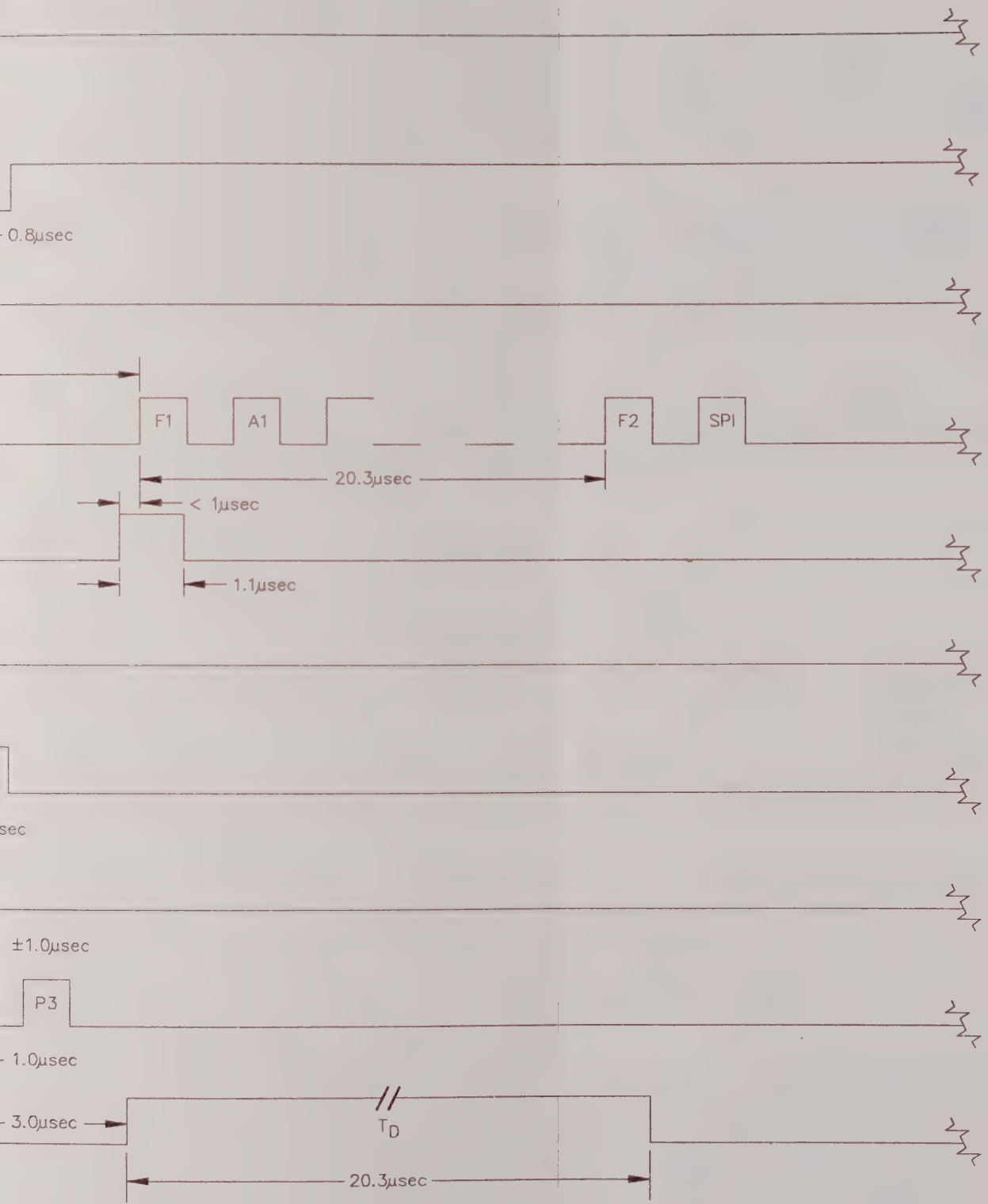
For Ext.Mod.In=ON, both sync and the pulse information may be received from an external source, allowing the user complete control over PRF and pulse patterns. The operator should note that PRF rate limitations specified for internal sync operation apply to external PRF rate as well.

Ext.Sync.:Out=ON is provided to connect two Mode S Test Systems together for complete power level diversity testing.

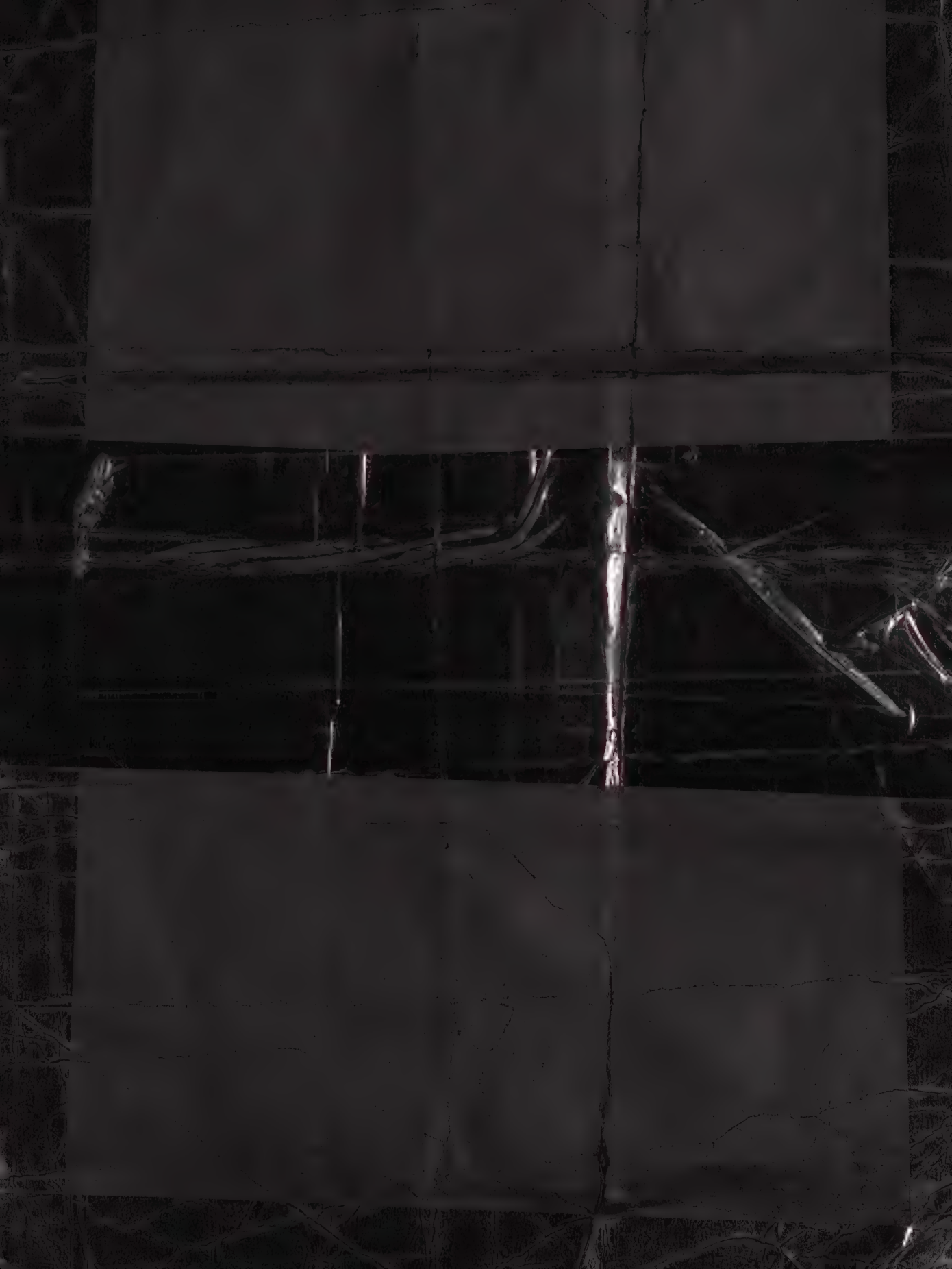
ANT B output, when enabled on Control Menu #1, will track ANT A output (with the exception of pulse level control). No power measurements are available for replies from ANT B.

The Scope Trigger allows the operator to view the detected video of either the generated or received signal with T_O/TAC/T_D Switch (30).


SELF INTERROGATE SYNC (J10010, PIN 14)
1.0µsec
−17.95µsec
MODE SPACING
EXT PULSE (J10010, PIN 5)
P1
P2
SLS GATE (J10010, PIN 6)
UUT REPLY DELAY (3.0µsec ±0.5µsec TYP)
UUT REPLY IS RECEIVED BY ATC−1400A, SENT TO S−1403
REPLY INPUT 50% VIDEO (J10010, PIN 11)
S−1403 GENERATES A GATE (WHEN SELECTED) TO ATC−1400A FOR UUT FREQ AND POWER MEASUREMENT.
PULSE POWER MEASUREMENT GATE OUT (J10014)
6.0µsec
WHEN ENABLED
EXT SYNC IN (J10004)
WHEN ENABLED
EXT MOD IN (J10003)
−9.95µsec TO +9.95µsec IN 50nsec STEPS
EXT SYNC OUT (J10008)
DEVIATION
P1
P2
ANT B (J10002)
1.0µsec
SCOPE−TRIGGER (J10007) MODE S/ATCRBS DISCRETE
TO



ATC Test Function Timing Chart
Figure 10



B. SEQ Test Function

NOTE: The following four items highlight some special considerations for SEQ Test Function. Review these items and the anomalies for SEQ Test Function listed in Appendix F, System Anomalies.

Sequence menu items (S01-S16) must be programmed prior to enabling SEQ Test Function, to avoid parity error messages from being generated from replies received during the programming of the item.

SLS/ECHO ON/OFF Switch (18) overrides P2 variable control to allow P5 control when ON.

PRF limitation for SEQ Test Function is 200.

Only the Mode S preamble is detected for calculating %Reply:S=. All other replies, including invalid replies are considered ATCRBS.

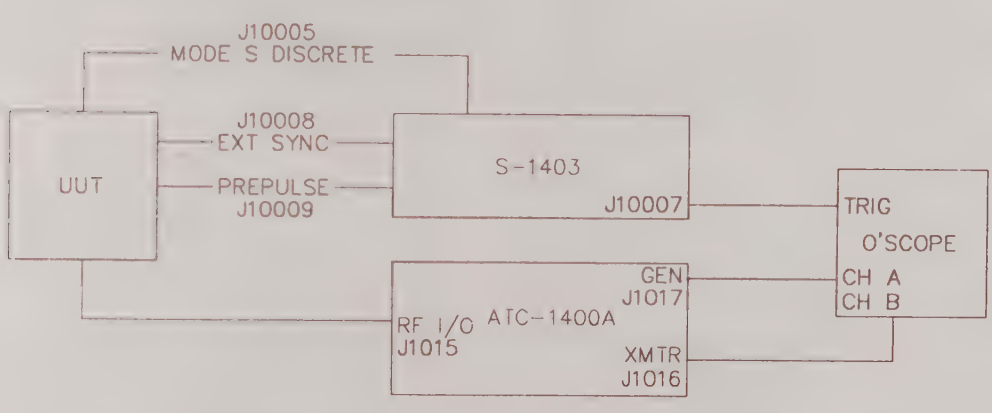


Figure 11 SEQ Test Function Hook-up Diagram

(1) Description of SEQ Test Function.

NOTE: Items identified with alphabetic characters refer to the S-1403, Items identified with numerical characters refer to the ATC-1400A.

The SEQ Test function, utilizing sequence menus (2nd, SMENU, #), allows Mode S interrogations to occur as defined by active sequence menus. Sequence Menus 1 thru 7 are predefined for uplink and downlink messages. Appendix B contains Sequence Menu definitions. Appendix E contains definitions for sub-fields within the sequence menu.

NOTE: When testing the UUT, recommend sequence menus not required for the specific test being conducted be turned off.

SEQ Test Function verifies the UUT's (when equipped with the specific function) capability to transmit/receive Mode S discrete address, pressure altitude, maximum airspeed, transponder 4096 code, on-the-ground report,special position indications, air-to-air messages, All-Call replies, All-Call transmissions, diversity response timing and capability of the UUT to respond to extended messages (116 bit messages, UF16 thru UF24, utilized in TCASI). All messages to/from the UUT are displayed in active (ON) sequence menus using OCTAL numeric format. Section 1-2-4, Remote (GPIB) Operations contains examples of how to convert GPIB Uplink and Downlink messages for specific suspect UUT operations.

Address (ADD= fields in all sequence menus) verification is used in Mode S replies and interrogations to provide protection against the UUT acting upon information directed to another address. Upon receipt of a Mode S interrogation, the UUT performs a parity check of the twenty four bits comprising the address code, to verify the bit sequence is consistant with the preprogrammed structure. If the bit sequence is consistent, the address verification is passed; otherwise it is failed. When an address verification fails, the UUT will not accept the interrogation and the two ADD= field in all active sequence menus will not display equal values.

(2) Control Menu #1 Display Definition

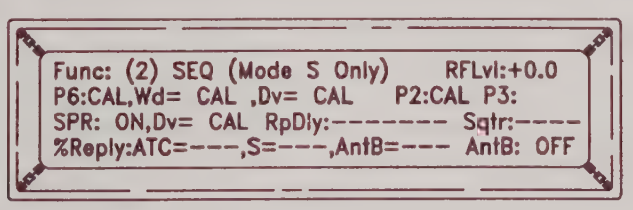


Figure 12 - SEQ Control Menu #1

Func: (2) SEQ (Mode S Only).
This mode interrogates the Mode S Transponder with the interrogation words stored in the Sequence Menu. Every menu item that is not OFF is transmitted in numerical sequence, one format per

interrogation. The sequence formats are programmed per Section 1-2-2. The PRF interrogation rate is controlled by PRF/SQTR Thumbwheels (41) and PRF/SQTR ON/OFF Switch (32).

RFLvl: Adjustments for RF Levels in 0.1 dB steps (within a range of ±3.0 dB). RF adjustments are in addition to the level shown in RF LEVEL -dBm Display (3). Adjustments of 1 dB or greater should be accomplished utilizing SLEW Control (6).

P_6: Select "CAL" (ON), "OFF" for Mode S P_6 Control.

P_6,Wd=: P_6 Pulse width control. Select CAL/VAR with the ON/CAL key. CAL (±0.0) = 16.25 µs for 56-bit data field and 30.25 µs for 112-bit data field. Variable values are the CAL value 1.5 µs in 0.05 µs steps.

P_6,Dv=: P_6 Pulse deviation control selections. Select CAL/(Value) with the ON/CAL key. CAL (0.0) = 3.5 µs following P_1. Variable values are the CAL value ±1.95 µs in 0.050 µs steps.

P_2: Mode S P_2 pulse level control selections: "CAL", "OFF" or "VAR". CAL resets the level to 0.0 dB. VAR indicates level control from SLS/ECHO Thumbwheel (50) when SLS/ECHO ON/OFF Switch (18) is OFF (i.e., P_5 not enabled). XPDR PULSE WIDTH Thumbwheels (49) and VAR/CAL Switch (20) control the P_2 pulse width. XPDR P_2/P_3 DEV Thumbwheels (44) control deviation.

P3: Not active in SEQ Test Function.

SPR: ON/OFF control for the Sync Phase Reversal.

SPR:Dv= — SPR deviation control selections. Select CAL/(Value) with the ON/CAL key. CAL (±0.0) = 1.25 µs following P_6. Variable values are the CAL value ±1.0 µs in 0.050 µs steps.

RpDly: — Displays the measured reply delay for Mode S (128 µs typical) interrogations with 25 ns resolution and 50 ns accuracy.

Sqtr: — Displays squitter period (transmission interval of DF=11 downlink format) from 0.0 to 9.99 sec with 10 ms resolution.

%Reply:ATC= — Displays any replies that are not valid Mode S replies or squitters from 0-127 in 1% steps.

%Reply:S= — Displays percent of valid Mode S only replies, from 0 to 127%, in 1% steps.

%Reply:AntB= — Displays percent of replies received from ANT B connector, from 0 to 127%, in 1% steps.

AntB: — Enables (delay value) or disables (OFF) Channel B, the diversity generator. When enabled, a value from -0.95 to +0.95 µs can be selected in 0.05 µs steps as the delay from Channel A to Channel B.

(3) Control Menu #2 Display Definition

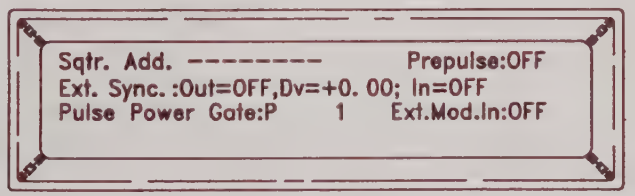


Figure 13 - SEQ Control Menu #2

Sqtr.Add.: — 24-bit octal value decoded from an unsolicited Channel A reply/squitter. This value is the Mode S Transponder address and transmitted via Downlink Format 11.

Prepulse:	Prepulse (=0 to 260)/OFF control. The pulse can be positioned 0 to 260 µs prior to the rising edge of the interrogation P_1 in 1.0 µs steps.
Ext.Sync.:Out=	ON/OFF control for external sync output function.
Ext.Sync.:Dv=	Deviation control for external sync output. The range of input is from -9.95 µs to +9.95 µs in 50 ns steps.
Ext.Sync.:In=	ON/OFF control for External Sync input control (positive TTL signal).
Pulse Power Gate:	Pulse power measurement gate tracks on reply delay and is selectable from P_1 to P_{116} by input of a number from 1 to 116 (or selected via SLEW Control [F]). For all reply pulses, the measurement gate must be enabled prior to the rising edge of the pulse to be measured. The measurement continues until the next reply falling edge. Since Mode S replies are in PPM format, care should be taken to ensure the data pulse prior to and following the measurement pulse are in a state where the power level is not measured as well. For example: measuring P_6 power; If P_6 is "0", P_5 state doesn't matter and P_7 should be "0". If P_6 is a "1", P_5 should be a "1" and P_7 is neutral. If P_5 were "0" and P_6 a "1", no rising edge would be detected and therefore the power reading would be zero. For the S-1403 to control pulse power measurement requires F_2/P_2-F_1/P_1 Switch (34) to be in the F_2/P_2 position. The F_1/P_1 position will measure the pulse power of an ATCRBS F_1 reply pulse only. The power measurement is performed in the ATC-1400A and displayed on the XMTR PWR WATTS Display (1).

Ext.Mod.In.: ON Disables the internal pulse generator.
OFF Allows simultaneous internal/ external modulation.

(4) Sequence Menu (Uplink/Downlink) Description

(a) Sequence Menu S01 - Uplink/Downlink Format 00 (Short Special Surveillance)

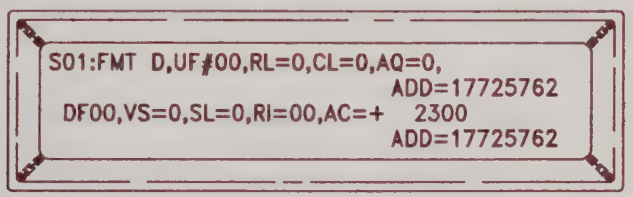


Figure 14 - Sequence menu S01

The Mode S Test System queries the UUT designating the expected response definition (DF00 or DF16) in field RL. When RL field is set to 0, the response will be DF00 (short format reply) as shown in figure 14. RL field equal to 1 declares DF16 (extended or long reply format) as the proper reply. Field CL is reserved for TCAS capable UUT's. When CL is zero, the default condition, TCAS has not generated a resolution advisory. A resolution advisory has been generated when CL is set to 1. AQ field is the command field for both UF00 and UF16. When AQ field is equal to zero (default condition for sequence menu S01), UF00 is the interrogation format. AQ field equal to 1 will direct UF16 to be the interrogation format.

Replies to the UUT, displayed as either DF00 or DF16, are determined by the value in field RL. Field VS determines the flight status of the UUT. Field AC represents the altitude related to the value in field VS. When VS is set to 1, representing an inflight condition, the value in AC symbolizes a flight altitude. VS field equal to 0 represents an on-ground condition and field VS symbolizes the airfield elevation. SL field reports TCAS sensitivity of the UUT to the interrogator (default is 0). Field RI is utilized to relay airspeed information to the interrogator. Codes 0 through 7 indicate an air-to-air non-acquisition reply. Codes 8 through 15 and an explanation of field SL are explained in Appendix E.

(b) Sequence Menu S02 - Uplink/Downlink Format 04 (Surveillance and Altitude Request)

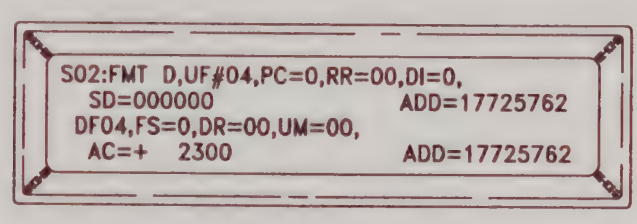


Figure 15 - Sequence Menu S02

Sequence Menu 02 PC= field mandates operating instructions to the UUT. Choices of selection in field PC= are non-selective All-Call lockout (1), cancel Comm-B (4), cancel Comm-C (5) or cancel Comm-D (6). Field RR instructs the UUT to reply in either short (codes 0 through 15) or long (codes 16 through 31) format. RR values of 16 through 31 will reply utilizing DF21. Field DI instructs the UUT to receive information contained in field SD. DI equal to 0 instructs the UUT to ignore all SD field data. When DI is set to 1, SD field is for multisite use. Setting DI to 7 will instruct the UUT to reply in extended field format (refer to Appendix E). Values of 2 through 6 are not defined.

Field FS reports flight status and alerts conditions (refer to Appendix E) to the interrogator. Field DR notifies the interrogator of the UUT's intent to transmit a message. A value of 0 represents no activity. When DR is equal to 1 the message will be Comm-B format. DR field values of 16 through 31 represent a Comm-D protocol message. Values of 2 through 15 are not defined. Field UM contains the transponders status (refer to Appendix E) when DI is 1 and SD is XXXXAX (X represents any value, A represents any non-zero value). The status contains the identity of the interrogator and the Comm format for further communications. Field AC displays altitude in feet, unless the UUT is coded to reply in meters.

(c) Sequence Menu S03 - Uplink/Downlink Format 05 (Aircraft Identification Request)

Sequence Menu 03 PC= field mandates operating instructions to the UUT. Choices of selection in field PC= are non-selective All-Call lockout (1), cancel Comm-B (4), cancel Comm-C (5) or cancel Comm-D (6). Field RR= instructs the UUT

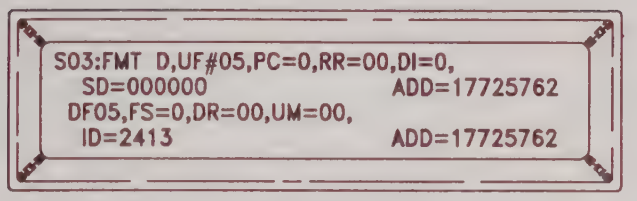


Figure 16 - Sequence Menu S03

to reply in either short (codes 0 through 15) or long (codes 16 through 31) format. RR= 16 through 31 will reply in DF21. Field DI instructs the UUT to receive information contained in field SD. DI equal to 0 instructs the UUT to ignore all SD field data. When DI is set to 1, SD field is for multisite use. Setting DI to 7 will instruct the UUT to reply in extended field format (refer to Appendix E). Values of 2 through 6 are not defined.

Field FS reports flight status and alerts conditions (refer to Appendix E) to the interrogator. Field DR notifies the interrogator of the UUT's intent to transmit a message. A value of 0 represents no activity. When DR is equal to 1 the message will be Comm-B format. DR field values of 16 through 31 represent a Comm-D protocol message. Values of 2 through 15 are not defined. Field UM contains the transponders status (refer to Appendix E) when DI is 1 and SD is XXXXAX (X represents any value, A represents any non-zero value). The status contains the identity of the interrogator and the Comm format for further communications. Field ID contains the 4096 identification code set on the UUT.

(d) Sequence Menu S04 - Uplink/Downlink Format 11 (Mode S Only All-Call)

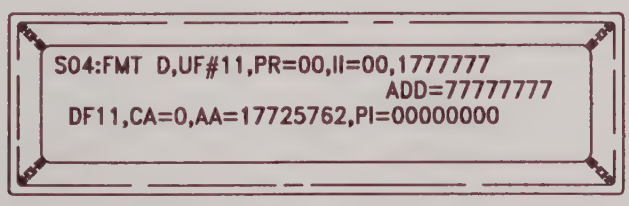


Figure 17 - Sequence Menu S04

Sequence Menu S04 PR field specifies the reply probability for replies from the UUT. This reply probability is used to separate replies in a saturated ATC environment. When PR field equals 0 or 8, the UUT replies normally. When PR is 5, 6, 7, 13, 14 or 15, the UUT is instructed to not reply. Other PR field codes are contained in Appendix E. Field II identifies the interrogator for future All-Call lockouts. The seven digits after field II= is a constant value of 1777777.

Field CA notifies the interrogator of the UUT's capability to reply. When CA is 0, the UUT is unable to reply in extended formats (DF16 through 24). When CA is 1, the UUT can reply in Comm-A, Comm-B and extended formats. When CA is 2, the UUT can reply in Comm-A, Comm-B, Comm-C and extended formats. When CA is 3, the UUT can reply utilizing any Mode S format. Field AA contains the UUT address. This field should be equal to the uplink ADD field. PI= field contains the parity code overlaid on the interrogator's identity code.

(e) Sequence Menu S05 - Uplink/Downlink Format 16 (Long Special Surveillance)

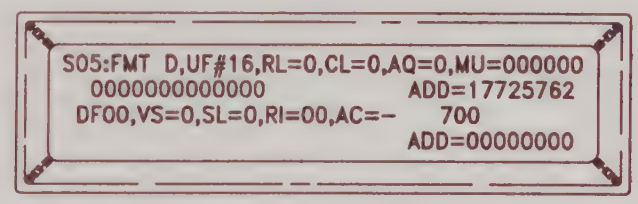


Figure 18 - Sequence Menu S05

The Mode S Test System queries the UUT designating the expected response definition (DF00 or DF16) in field RL. When RL field is set to 0, the response will be DF00 (short format reply) as shown in figure 18. RL field equal to 1 declares DF16 (extended or long reply format) as the proper reply. Field CL is reserved for TCAS capable UUT's. When CL is zero, the default condition, TCAS has not generated a resolution advisory. A resolution advisory has been generated when CL is set to 1. AQ field is the command field for both UF00 and UF16. When AQ field is equal to zero, UF00 is the interrogation format. AQ field equal to 1 (default condition for sequence menu S05) will direct UF16 to be the interrogation format. This sequence menu is dedicated for long (112 bit) responses for air-to-air requests. In responding to UF16, the UUT will reply with

altitude and response format information. Further communications will be through either unspecified long Downlink formats (22 or 23) or Downlink format 24. UF16 will not follow Comm-B formats. Field MU contains information used in air-to-air exchanges.

Replies to the UUT, displayed as either DF00 or DF16, are determined by the value in field RL. Field VS determines the flight status of the UUT. Field AC represents the altitude related to the value in field VS. When VS is set to 1, representing an in-flight condition, the value in AC symbolizes a flight altitude. VS field equal to 0 represents an on-ground condition and field VS symbolizes the airfield elevation. SL field reports TCAS sensitivity of the UUT to the interrogator (default is 0). Field RI is utilized to relay airspeed information to the interrogator. Codes 0 through 7 indicate an air-to-air non-acquisition reply. Codes 8 through 15 and an explanation of field SL are explained in Appendix E. Field MV contains information utilized in air-to-air exchanges and does not follow Comm-B format.

(f) Sequence Menu S06 - Uplink/Downlink Format 20 (Comm-A Altitude Request)

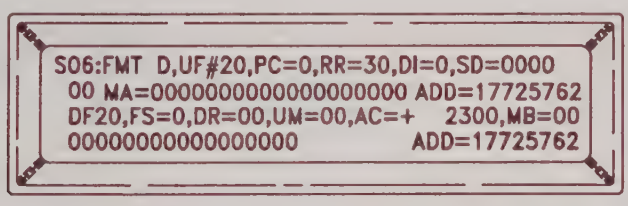


Figure 19 - Sequence Menu S06

Sequence Menu 06 PC field mandates operating instructions to the UUT. Choices of selection in field PC are non-selective All-Call lockout (1), cancel Comm-B (4), cancel Comm-C (5) or cancel Comm-D (6). Field RR= instructs the UUT to reply in either short (codes 0 through 15) or long (codes 16 through 31) format. RR= 16 through 31 will reply in DF21. Field DI instructs the UUT to receive information contained in field SD. DI equal to 0 instructs the UUT to ignore all SD field data. When DI is set to 1, SD field is for multisite use. Setting DI to 7 will

instruct the UUT to reply in extended field format (refer to Appendix E). Values of 2 through 6 are not defined. Field MA contains messages to the UUT and uses Comm-A format.

Field FS reports flight status and alerts conditions (refer to Appendix E) to the interrogator. Field DR notifies the interrogator of the UUT's intent to transmit a message. A value of 0 represents no activity. When DR is equal to 1, the message will be Comm-B format. DR field values of 16 through 31 represent a Comm-D protocol message. Values of 2 through 15 are not defined. Field UM contains the transponders status (refer to Appendix E) when DI is 1 and SD is XXXXAX (X represents any value, A represents any non-zero value). The status contains the identity of the interrogator and the Comm format for further communications. Field AC displays altitude in feet, unless the UUT is coded to reply in meters. Field MB contains messages to the interrogator and uses Comm-B format.

(g) Sequence Menu S07 - Uplink/Downlink Format 21 (Comm-A Identity Request)

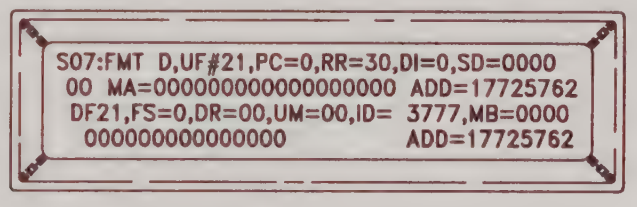
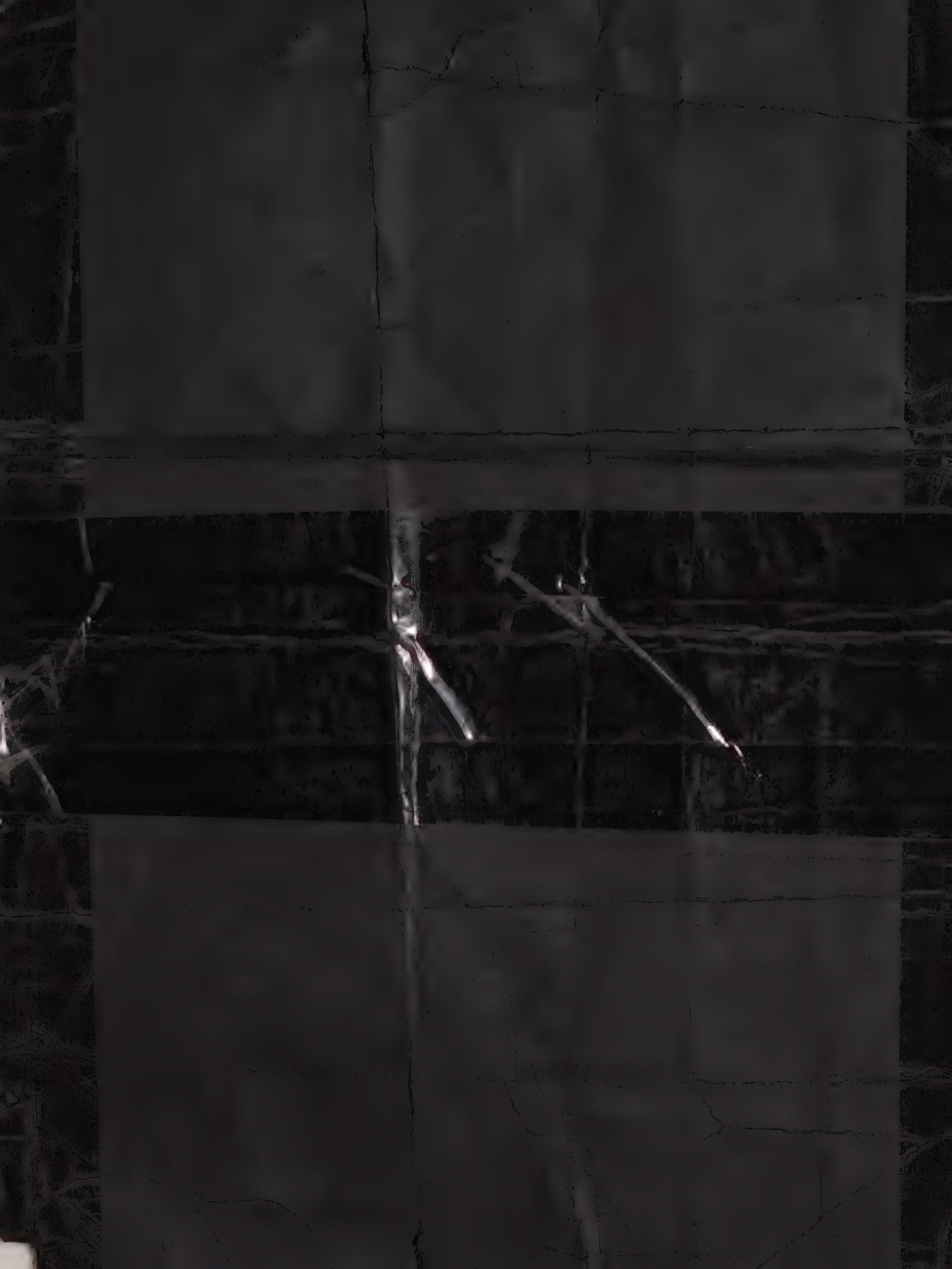
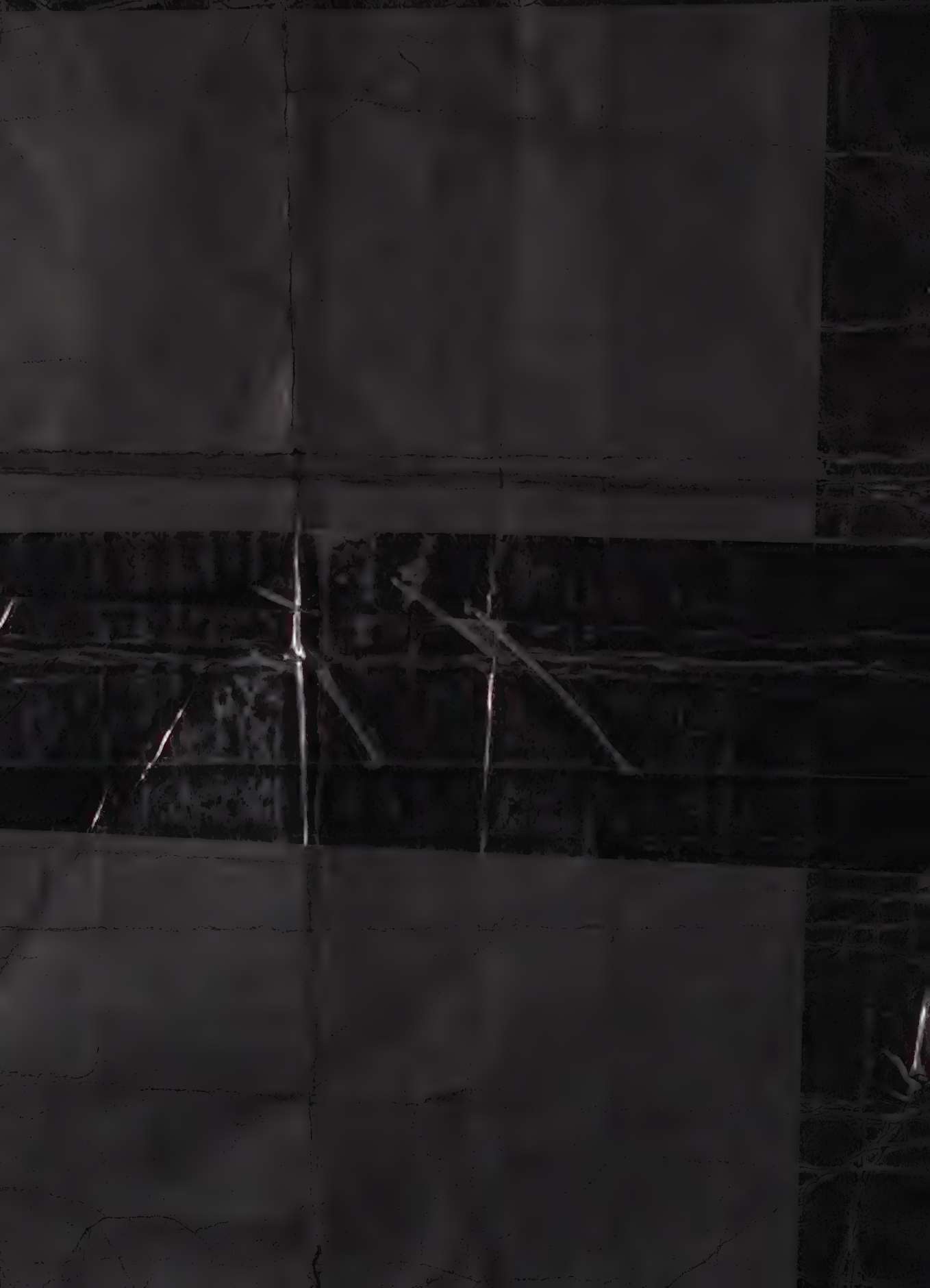


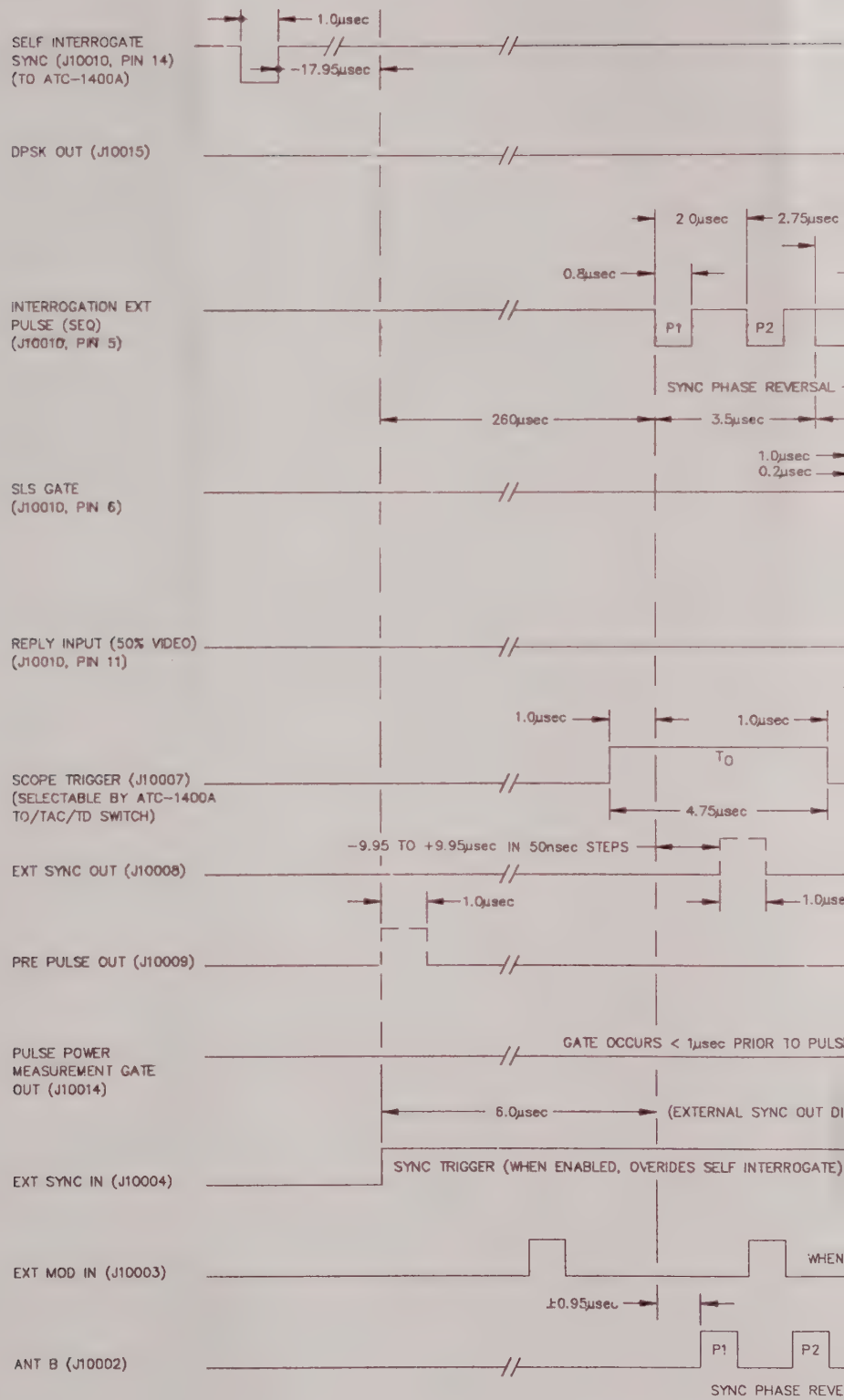
Figure 20 - Sequence Menu S07

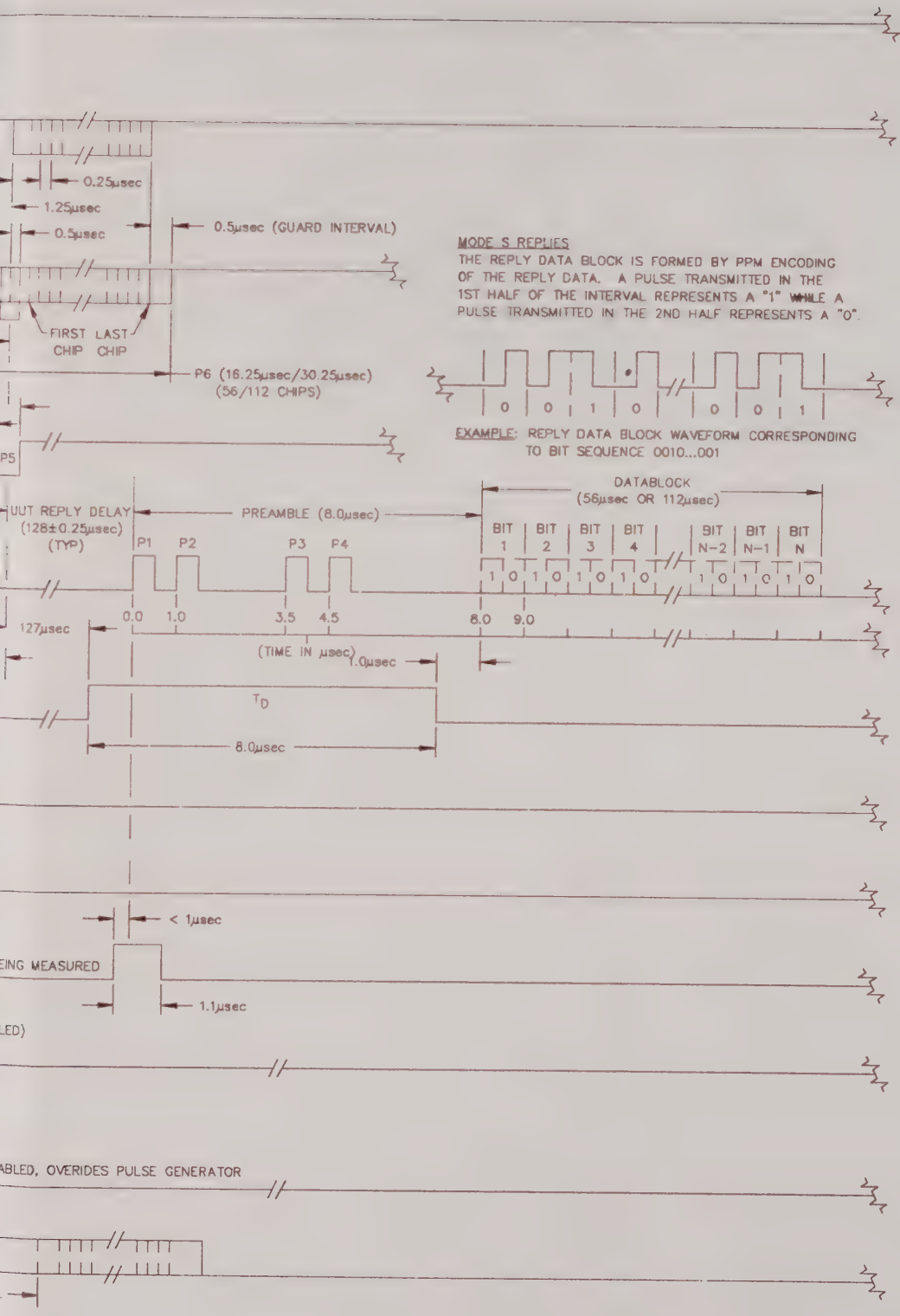
Sequence menu S07 PC= field mandates operating instructions to the UUT. Choices of selection in field PC= are non-selective All-Call lockout (1), cancel Comm-B (4), cancel Comm-C (5) or cancel Comm-D (6). Field RR instructs the UUT to reply in either short (codes 0 through 15) or long (codes 16 through 31) format. RR 16 through 31 will reply in DF21. Field DI instructs the UUT to receive information contained in field SD. DI equal to 0 instructs the UUT to ignore all SD field data. When DI is set to 1, SD field is for multisite use. Setting DI to 7 will instruct the UUT to reply in extended field format (refer to Appendix E). Values of 2 through 6 are not defined. Field MA contains messages from the interrogator to the UUT.

Field FS reports flight status and alerts conditions (refer to Appendix E) to the interrogator. Field DR notifies the interrogator of the UUT's intent to transmit a message. A value of 0 represents no activity. When DR is equal to 1, the message will be Comm-B format. DR field values of 16 through 31 represent a Comm-D protocol message. Values of 2 through 15 are not defined. Field UM contains the transponders status (refer to Appendix E) when DI is 1 and SD is XXXXAX (X represents any value, A represents any non-zero value). The status contains the identity of the interrogator and the Comm format for further communications. ID contains the 4096 code selected on the front of the UUT. Field MB contains messages to the interrogator and uses Comm-B format.






1.0µsec
SELF INTERROGATE SYNC (J10010, PIN 14) (TO ATC-1400A)
~17.95µsec
DPSK OUT (J10015)
2.0µsec
2.75µsec
0.8µsec
INTERROGATION EXT PULSE (SEQ) (J10010, PIN 5)
P1
P2
SYNC PHASE REVERSAL
260µsec
3.5µsec
1.0µsec
0.2µsec
SLS GATE (J10010, PIN 6)
REPLY INPUT (50% VIDEO) (J10010, PIN 11)
1.0µsec
1.0µsec
T0
SCOPE TRIGGER (J10007) (SELECTABLE BY ATC-1400A TO/TAC/TD SWITCH)
4.75µsec
-9.95 TO +9.95µsec IN 50nsec STEPS
EXT SYNC OUT (J10008)
1.0µsec
1.0µse
PRE PULSE OUT (J10009)
GATE OCCURS < 1µsec PRIOR TO PULS
PULSE POWER MEASUREMENT GATE OUT (J10014)
6.0µsec
(EXTERNAL SYNC OUT DI
SYNC TRIGGER (WHEN ENABLED, OVERIDES SELF INTERROGATE)
EXT SYNC IN (J10004)
EXT MOD IN (J10003)
WHEN
±0.95µsec
P1
P2
ANT B (J10002)
SYNC PHASE REVE



SEQ Test Function Timing Chart
Figure 21

C. ACS Test Function

NOTE: S-1403 Controls are identified by alphabetic character identifiers whereas all ATC-1400A controls are identified by numeric character identifiers.

NOTE: The following four items highlight ACS Test Function anomalies. Review these items and Appendix F prior to utilizing this test function.

The PRF rate (as set by the ATC-1400A PRF/SQTR thumbwheel switches (41)) is limited to 1500 ATCRBS interrogations with replies occurring (RATE ERROR occurs) and 800 without replies (with P4 disabled, no error message indicated).

The ACS Scope Trigger (J10007) occurs 3.0 microseconds early with an ATCRBS reply (P4 disabled) when the ATC-1400A SYNC switch (30) is in TD position.

Reply delay is measured from the leading edge of the P4 pulse when the P4 control is in CAL or VAR position. When P4 is turned OFF, the measurement is made from the leading edge of the P3 pulse.

Downlink information is not decoded in the Sequence Menu for this function.

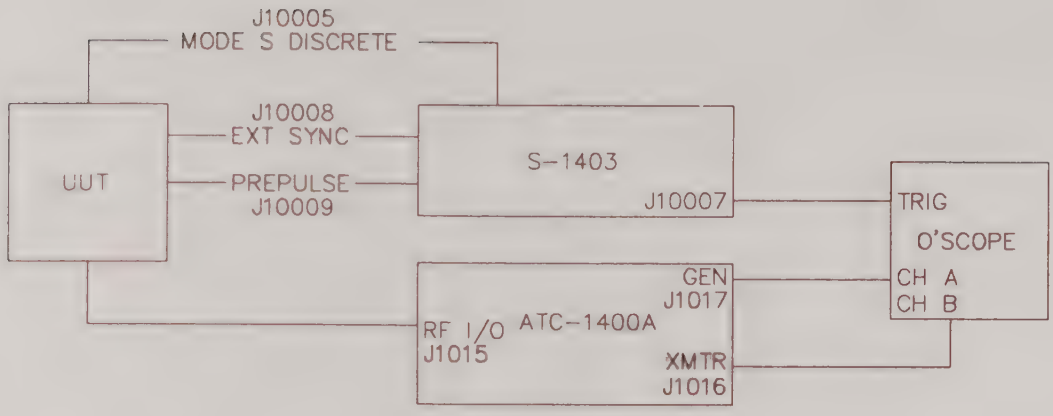


Figure 22 ACS Test Function Hook-up Diagram

(1) Description of ACS Test Function.

ACS (All Call Short) function selects only All Call Short interrogations for transmissions. No other ATCRBS or Mode S interrogations are permitted (ACS disables Mode S replies in the Mode S Transponder allowing only ATCRBS replies).

(2) Control Menu #1 Display Definition

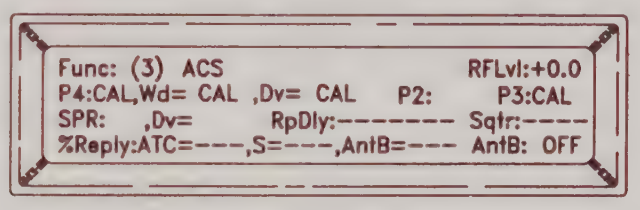


Figure 23 - ACS Control Menu #1

Func: (3)ACS.
Modes are selected by XPDR MODE Control (38). PRF/SQTR Thumbwheels (41) and PRF/SQTR ON/OFF Switch (32) control PRF rate for the interrogations.

RFLvl: Adjustments for RF Levels in 0.1 dB steps (within a range of ±3.0 dB). RF adjustments are in addition to the level shown in RF LEVEL -dBm Display (3). Adjustments of 1 dB or greater should be accomplished utilizing RF LEVEL Control (6).

P_4:	Select "CAL", "OFF" or "VAR" for P_4. CAL resets the level to 0.0 dB. VAR allows variable amplitude control with SLS/ECHO ON/OFF Switch (18) in the OFF position. Setting the SLS/ECHO ON/OFF Switch (18) to ON overrides P_3 and P_4 variable control, changing control to SLS (P_2).
P_4,Wd=:	Pulse width variable control selection. Select CAL/(Value) with the ON/CAL key. CAL (0.0)= 0.8 µs for ACS. Variable values are adjustable from CAL value -0.6 to +1.95 µs in 0.05 µs steps.
P_4,Dv=:	Pulse deviation control selection. Select CAL/(Value) with the ON/CAL key. CAL (±0.0) = 8.0 µs for ATCRBS Mode A, and 21.0 µs for ATCRBS Mode C. Variable control provides deviation from CAL value ±1.95 µs in 0.05 µs steps.
P_2:	Not active in ACS Test Function.
P_3:	Mode S All Call P_3 pulse level control selection: "CAL", "OFF", or "VAR". CAL resets the level to 0.0 dB. SLS/ECHO Thumbwheels (50) controls VAR level when the SLS/ECHO ON/OFF Switch (18) is OFF (P_2 not enabled). XPDR P_2/P_3 DEV Thumbwheels (44) and XPDR DEV P_3/CAL Switch (25) control the P_3 pulse deviation. XPDR PULSE WIDTH Thumbwheels (49) and XPDR PULSE WIDTH VAR/CAL Switch (20) control pulsewidth.
SPR:	Not active in ACS Test Function.
SPR:Dv=	Not active in ACS Test Function.
RpDly:	Displays the measured reply delay for Mode S (128 µs typical) interrogations with 25 ns resolution and 100 ns accuracy.
Sqtr:	Displays squitter period (transmission interval of DF=11 downlink format) from 0.0 to 9.99 sec with 10 sec resolution.

%Reply:ATC= Displays percent of ATCRBS replies only, from 0 to 127% in 1% steps.

%Reply:S= Displays percent of Mode S replies only, from 0 to 127% in 1% steps.

%Reply:AntB= Displays percent of replies received from the ANT B Connector (E), from 0 to 127% in 1% steps.

AntB: OFF/(delay value). Enables or disables Channel B, the diversity generator. When enabled, a value from -0.95 µs to +0.95 µs can be selected as the delay from Channel B in 0.05 µs steps.

(3) Control Menu #2 Display Definition

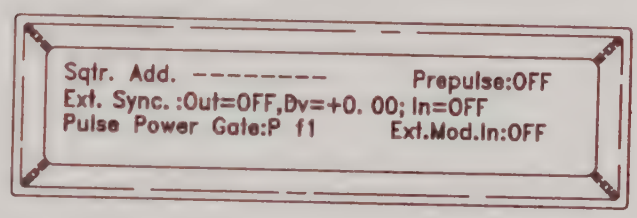


Figure 24 - ACS Control Menu #2

Sqtr. Add: 24 bit octal value decoded from an unsolicited Channel A reply/squitter. This value is the Mode S Transponder address and is transmitted via Downlink Format 11.

Prepulse: Prepulse ON/OFF Control. The prepulse spacing is set at the front panel. The pulse can be positioned from 0 to 260 µs prior to the rising edge of P_1 of the interrogation, in 1 µs steps.

Ext.Sync.:Out= ON/OFF control for the external sync output function.

Ext.Sync.:Dv= Deviation control for external sync output. The selectable range can vary from -9.95 µs to +9.95 µs in 50 ns steps.

Ext.Sync.:In= ON/OFF control for External Sync input control (positive TTL signal). EXT SYNC Out is not enabled when SYNC In is enabled.

Pulse Power Gate:

Pulse Power Measurement Gate tracks on reply delay and is selectable from P_1 to P_{116} (by input of a number from 1 to 116 or selected via SLEW Control [F]). The reply delay is used to determine the location to measure the PPMG pulse. This allows correct positioning regardless of P_4 location.

The power measurement is performed in the ATC-1400A and displayed on XMTR PWR WATTS Display (1).

For all reply pulses, the measurement gate must be enabled prior to the rising edge of the pulse to be measured. The measurement will continue until the next falling edge of the reply. In the case of Mode S replies, since they are in PPM format, care should be taken to ensure the data pulses prior to and following the pulse to be measured are in such a state that their power levels will not be measured as well. For example: to measure P_6 power: If P_6 is a "0" then P_5's state doesn't matter and P_7 should be a "0". If P_6 is a "1", then P_5 should be a "1" and P_7's state doesn't matter. If P_5 were "0" and P_6 a "1", no rising edge would be detected and therefore the power reading would be zero.

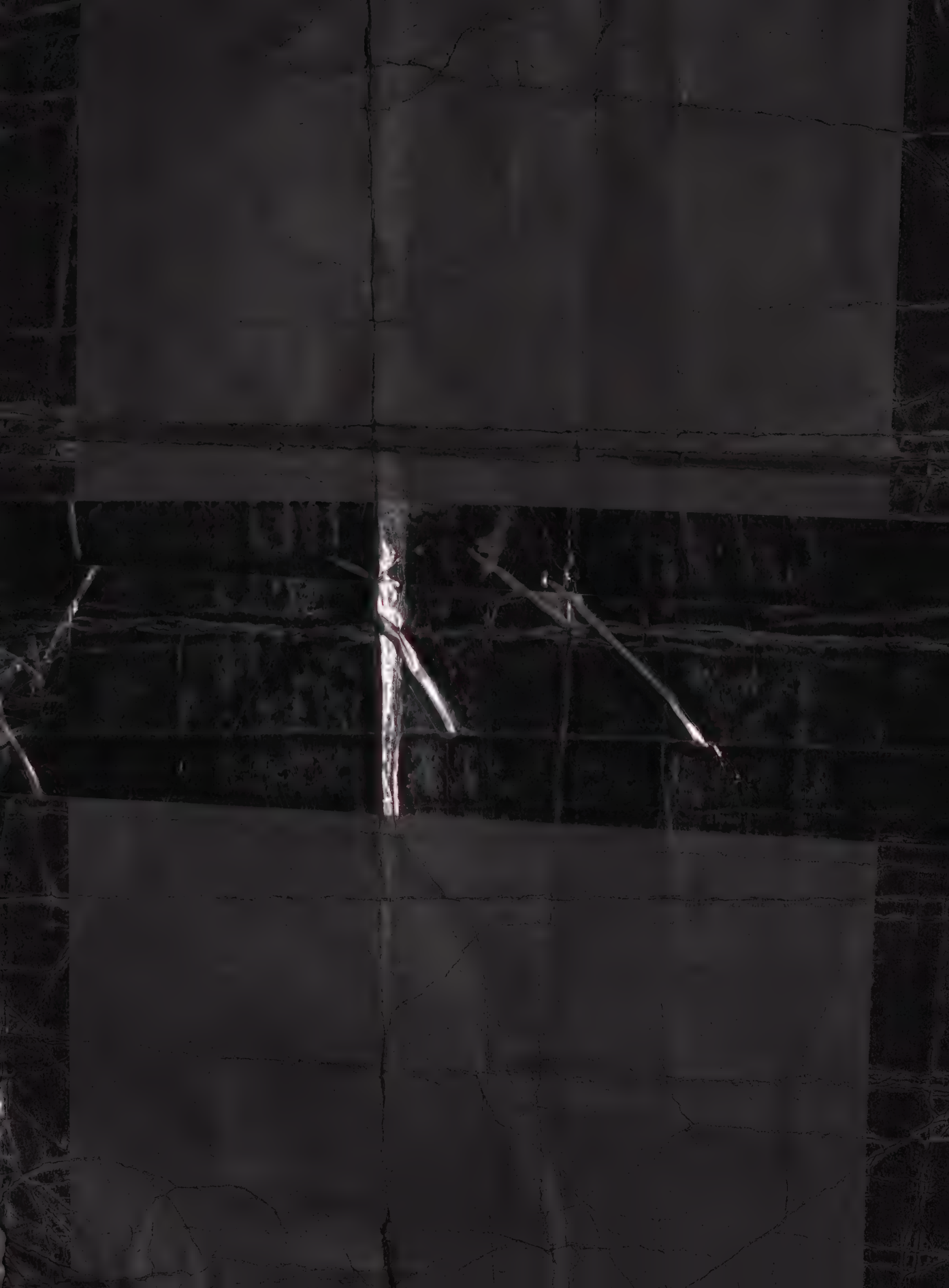
For the S-1403 to control pulse power measurement requires F_2/P_2-F_1/P_1 Switch (34) to be in the F_2/P_2 position. The F_1/P_1 position will measure the pulse power of an ATCRBS F_1 reply pulse only.

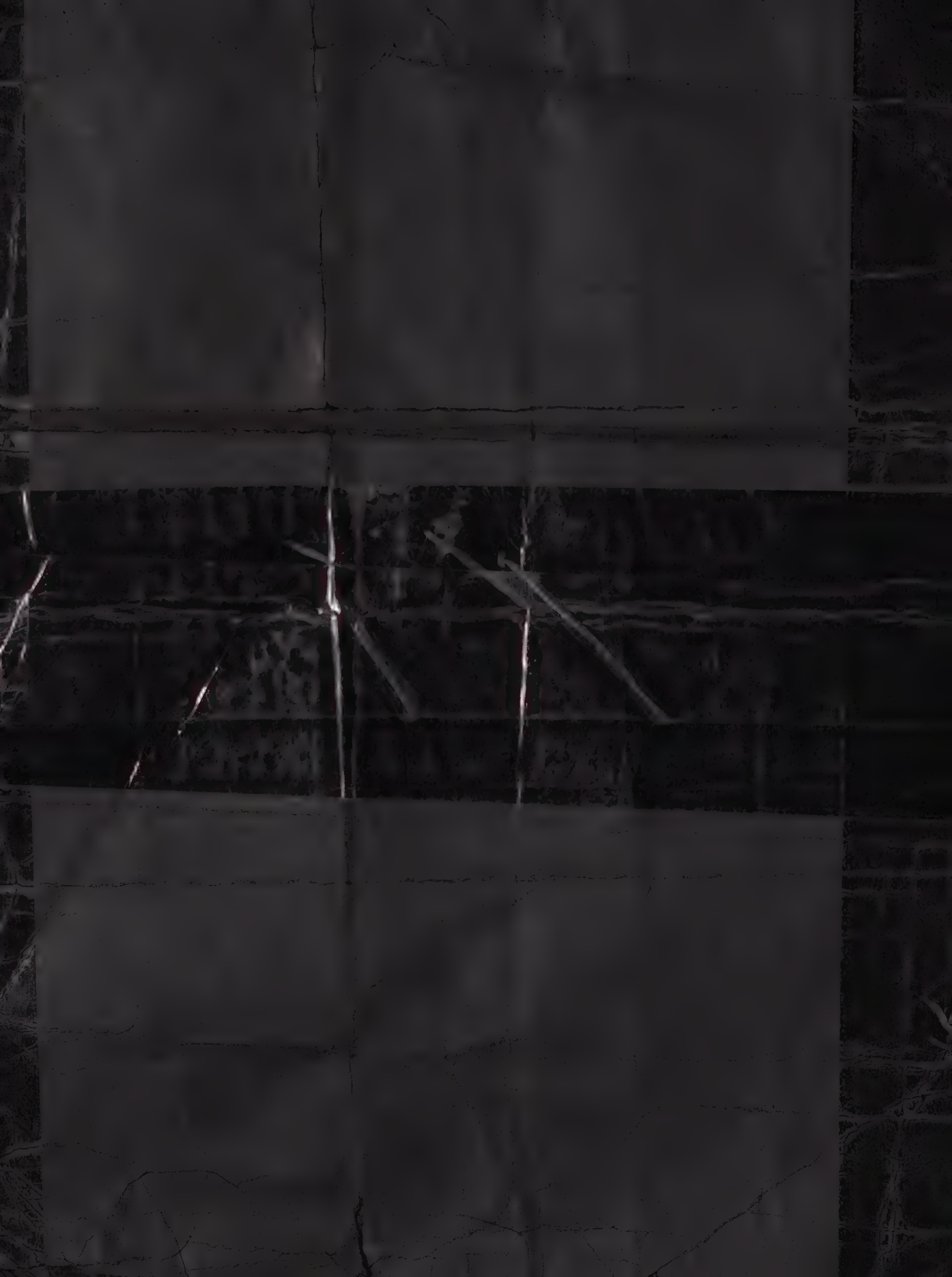
Ext. Mod.In.:

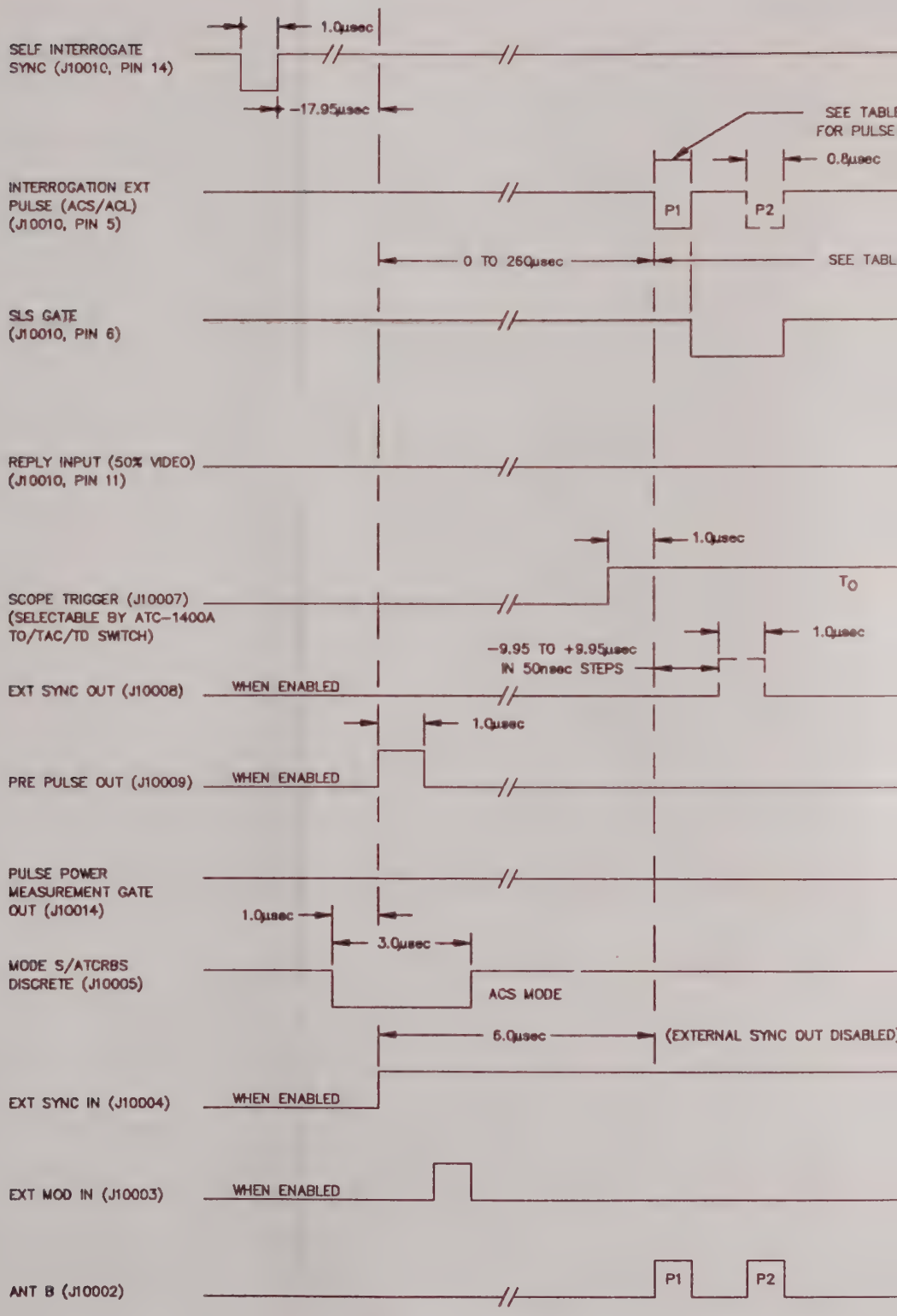
ON Disables the internal pulse generator.
OFF Allows simultaneous internal/ external modulation.

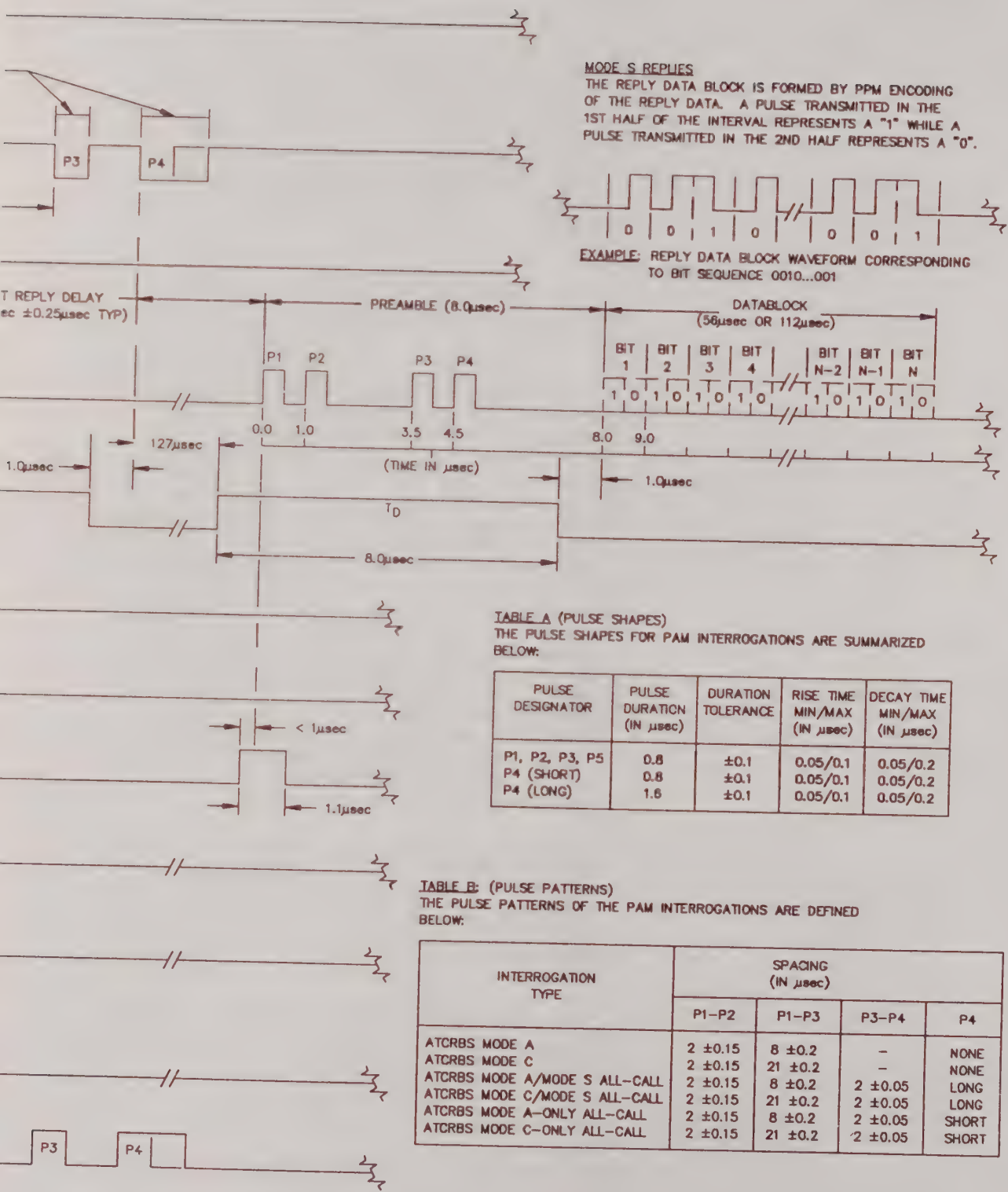
(4) Sequence Menu (Uplink/Downlink) Description

ACS Test Function does not utilize sequence menus.






SELF INTERROGATE SYNC (J10010, PIN 14)
1.0µsec
17.95µsec
SEE TABL
FOR PULSE
0.8µsec
INTERROGATION EXT PULSE (ACS/ACL) (J10010, PIN 5)
P1
P2
0 TO 260µsec
SEE TABL
SLS GATE (J10010, PIN 6)
REPLY INPUT (50% VIDEO) (J10010, PIN 11)
1.0µsec
TO
SCOPE TRIGGER (J10007) (SELECTABLE BY ATC-1400A TO/TAC/TD SWITCH)
1.0µsec
-9.95 TO +9.95µsec IN 50nsec STEPS
EXT SYNC OUT (J10008)
WHEN ENABLED
1.0µsec
PRE PULSE OUT (J10009)
WHEN ENABLED
PULSE POWER MEASUREMENT GATE OUT (J10014)
1.0µsec
3.0µsec
MODE S/ATCRBS DISCRETE (J10005)
ACS MODE
6.0µsec
(EXTERNAL SYNC OUT DISABLED)
EXT SYNC IN (J10004)
WHEN ENABLED
EXT MOD IN (J10003)
WHEN ENABLED
ANT B (J10002)
P1
P2



MODE S REPLIES
THE REPLY DATA BLOCK IS FORMED BY PPM ENCODING OF THE REPLY DATA. A PULSE TRANSMITTED IN THE 1ST HALF OF THE INTERVAL REPRESENTS A "1" WHILE A PULSE TRANSMITTED IN THE 2ND HALF REPRESENTS A "0".

EXAMPLE: REPLY DATA BLOCK WAVEFORM CORRESPONDING TO BIT SEQUENCE 0010...001

TABLE A (PULSE SHAPES)
THE PULSE SHAPES FOR PAM INTERROGATIONS ARE SUMMARIZED BELOW:

PULSE DESIGNATOR	PULSE DURATION (IN µsec)	DURATION TOLERANCE	RISE TIME MIN/MAX (IN µsec)	DECAY TIME MIN/MAX (IN µsec)
P1, P2, P3, P5	0.8	±0.1	0.05/0.1	0.05/0.2
P4 (SHORT)	0.8	±0.1	0.05/0.1	0.05/0.2
P4 (LONG)	1.6	±0.1	0.05/0.1	0.05/0.2

TABLE B: (PULSE PATTERNS)
THE PULSE PATTERNS OF THE PAM INTERROGATIONS ARE DEFINED BELOW:

INTERROGATION TYPE	SPACING (IN µsec)			
	P1–P2	P1–P3	P3–P4	P4
ATCRBS MODE A	2 ±0.15	8 ±0.2	–	NONE
ATCRBS MODE C	2 ±0.15	21 ±0.2	–	NONE
ATCRBS MODE A/MODE S ALL-CALL	2 ±0.15	8 ±0.2	2 ±0.05	LONG
ATCRBS MODE C/MODE S ALL-CALL	2 ±0.15	21 ±0.2	2 ±0.05	LONG
ATCRBS MODE A-ONLY ALL-CALL	2 ±0.15	8 ±0.2	2 ±0.05	SHORT
ATCRBS MODE C-ONLY ALL-CALL	2 ±0.15	21 ±0.2	2 ±0.05	SHORT

ACS/ACL Test Function Timing Chart
Figure 25

D. ACL Test Function

NOTE: S-1403 controls are identified by alhabetic character identifiers wheras all ATC-1400A controls are identified by numeric character identifiers.

NOTE: The following four items highlight ACL Test Function anomalies. Review these items and Appendix F prior to utilizing this test function

The PRF rate (set by PRF/SQTR Thumbwheels [41]) is limited to 1500 ATCRBS interrogations with replies occurring (rate error message occurs) and 800 without replies (P4 disabled, no error message indicated). In normal mode (P4 in CAL and Mode S reply), the PRF rate is limited to 200.

Scope Trigger (J10007) occurs 3.0 microseconds early with an ATCRBS reply (P4 disabled) when T0/TAC/TD Switch (30) is TD.

Reply delay is measured from the leading edge of the P4 pulse when the P4 field is set to CAL or VAR. When P4 field is OFF, the measurement is made from the leading edge of the P3 pulse.

SLS/ECHO ON/OFF Switch (18) overrides P3 and P4 variable control and controls the SLS pulse instead.

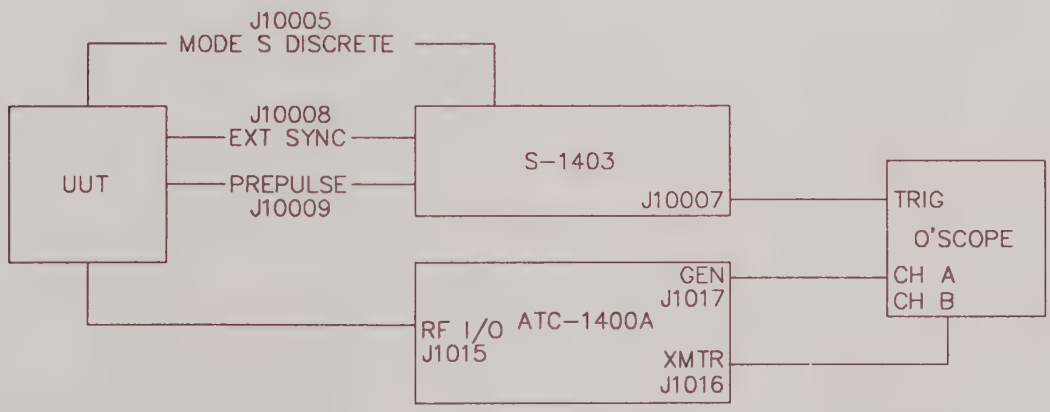


Figure 26 - ACL Test Function Hook-up Diagram

(1) Description ACL Test Function.

ACL (All Call Long) function transmits only All Call Long interrogations. ACL allows both Mode S and ATCRBS replies.

The Mode S only All-Call (ACL) is used by interrogators when Mode S aircraft are to be acquired without eliciting replies from ATCRBS only aircraft. The transponders address for this interrogation is all ones. The UUT will reply to this interrogation with its discrete address (ADD= field).

(2) Control Menu #1 Display Definition

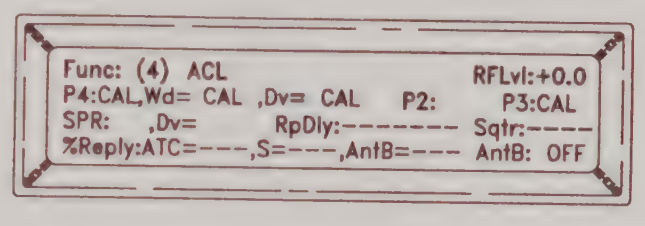


Figure 27 - ACL Control Menu #1

Func: (4) ACL
Modes are selected by XPDR MODE Control (38). PRF/SQTR Thumbwheels (41) and PRF/SQTR ON/OFF Switch (32) control the PRF rate for the interrogations.

RFLvl: Adjustments for RF Levels in 0.1 dB steps (within a range of ±3.0 dB). RF adjustments are in addition to the level shown in RF LEVEL -dBm Display (3). Adjustments of 1 dB or greater should be accomplished utilizing SLEW Control (6).

P_4: Select "CAL", "OFF" or "VAR" for P_4 control. CAL resets the level to 0.0dB. SLS/ECHO ON/OFF Switch (18) in the OFF position allows variable amplitude selection.

NOTE: In the ON position, SLS/ECHO ON/OFF Switch (18) overrides P_3 and P_4 variable control controlling SLS pulse instead.

P_4,Wd=: Pulse width variable control selections. Select CAL/(Value) with the ON/CAL key. CAL (±0.0) = 1.6 µs. Variable range is from +1.95 µs to -1.4 µs in 0.05 µs steps relative to CAL value.

P_4,Dv=:	Pulse deviation control selection. Select CAL/(Value) with the ON/CAL key. CAL (±0.0) = 8.0 µs for ATCRBS Mode A, and 21.0 µs for ATCRBS Mode C. Variable control to ±1.95 µs relative to CAL in 0.050 µs steps.
P_3:	Mode S All Call P_3 pulse level control selections are: "CAL", "OFF" or "VAR". CAL resets the level to 0.0 dB. SLS/ECHO Thumbwheels (50) controls the VAR level when the SLS/ECHO ON/OFF Switch (18) is OFF (i.e., P_2 is disabled). XPDR P_2/P_3 DEV Thumbwheels (44) and XPDR DEV P_3/CAL Switch (25) control the P_3 pulse deviation. XPDR PULSE WIDTH Thumbwheels (49) and XPDR PULSE WIDTH VAR/CAL Switch (20) control pulsewidth. SLS overrides P_3 variable control.
SPR:	Not active in ACL Test Function
SPR:Dv=	Not active in ACL Test Function
RpDly:	Displays measured reply delay for Mode S interrogations with 25 ns resolution and 50 ns accuracy.
Sqtr:	Displays squitter period (transmission interval of a DF=11 downlink format) from 0.0 to 9.99 sec with 10 ms resolution.
%Reply:ATC=	Displays percent of ATCRBS replies only, from 0 to 127% in 1% steps.
%Reply:S=	Displays percent of Mode S replies only, from 0 to 127% in 1% steps.
%Reply:AntB=	Displays percent of replies received from the ANT B Connector (E), from 0 to 127% in 1% steps.
AntB:	OFF/(delay value). Enables or disables Channel B, the diversity generator. When enabled, a value from -0.95 µs to +0.95 µs can be selected as the delay from Channel B in 0.05 µs steps.

(3) Control Menu #2 Display Definition

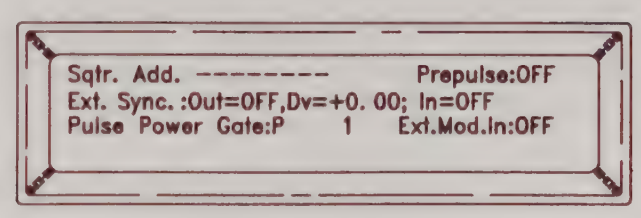


Figure 28 - ACL Control Menu #2

Sqtr.Add.: 24-bit octal value decoded from an unsolicited reply (squitter) on Channel A. This value is the Mode S transponder's address and is transmitted via downlink format 11.

Prepulse: Prepulse (0 to 260)/OFF control. The prepulse spacing is set on the front panel. The pulse can be positioned from 0 to 260 µs prior to the rising edge of P_1 of the interrogation in 1 µs steps.

Ext.Sync.:Out= ON/OFF control for the external sync output function.

Ext.Sync.:Dv= Deviation control for external sync output, ranging from -9.95 µs to +9.95 µs in 50 ns steps.

Ext.Sync.:In= ON/OFF control for external sync input (positive TTL signal). Overrides EXT SYNC OUT.

Pulse Power Gate: Pulse power measurement gate tracks on reply delay and is selectable from P_1 to P_{116} (by input of a number from 1 to 116 or selected via SLEW Control [F]). The reply delay is used to determine the location to measure the PPMG pulse. This allows correct positioning regardless of the P_4 pulse.

For all reply pulses, the measurement gate must be enabled prior to the rising edge of the pulse to be measured. The measurement will continue until the next falling edge of the reply. In

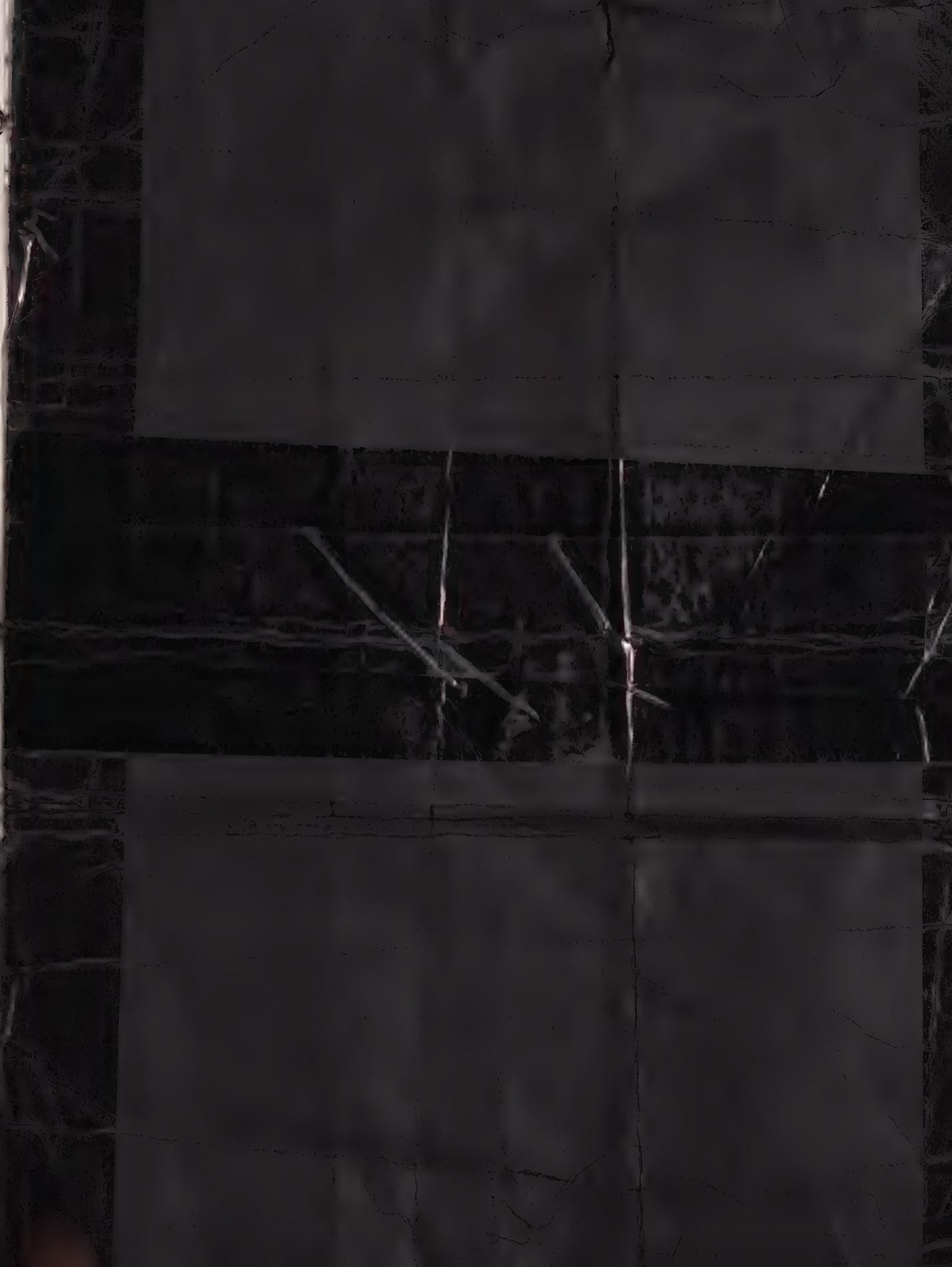
the case of Mode S replies, since they are in PPM format, care should be taken to ensure the data pulses prior to and following the pulse to be measured are in such a state that their power levels will not be measured as well. For example: to measure P_6 power; If P_6 is a "0", then P_5's state doesn't matter and P_7 should be a "0". If P_6 is a "1", then P_5 should be a "1" and P_7's state doesn't matter. If P_5 were "0" and P_6 a "1", no rising edge would be detected and therefore the power reading would be zero.

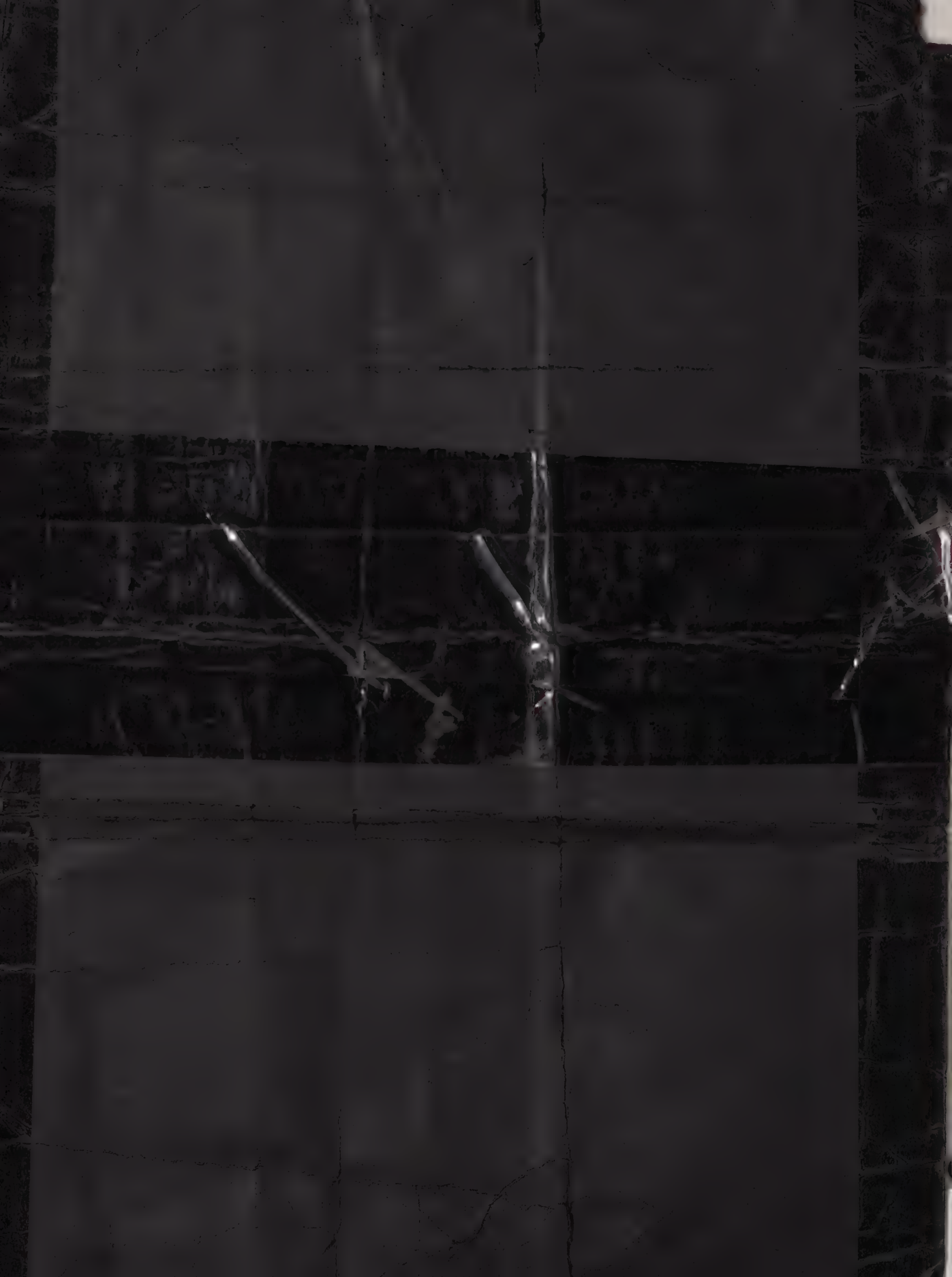
For the S-1403 to control pulse power measurement requires F_2/P_2-F_1/P_1 Switch (34) be in the F_2/P_2 position. The F_1/P_1 position will measure the pulse power of an ATCRBS F_1 reply pulse only. The power measurement is performed in the ATC-1400A and displayed on XMTR PWR WATTS Display (1).

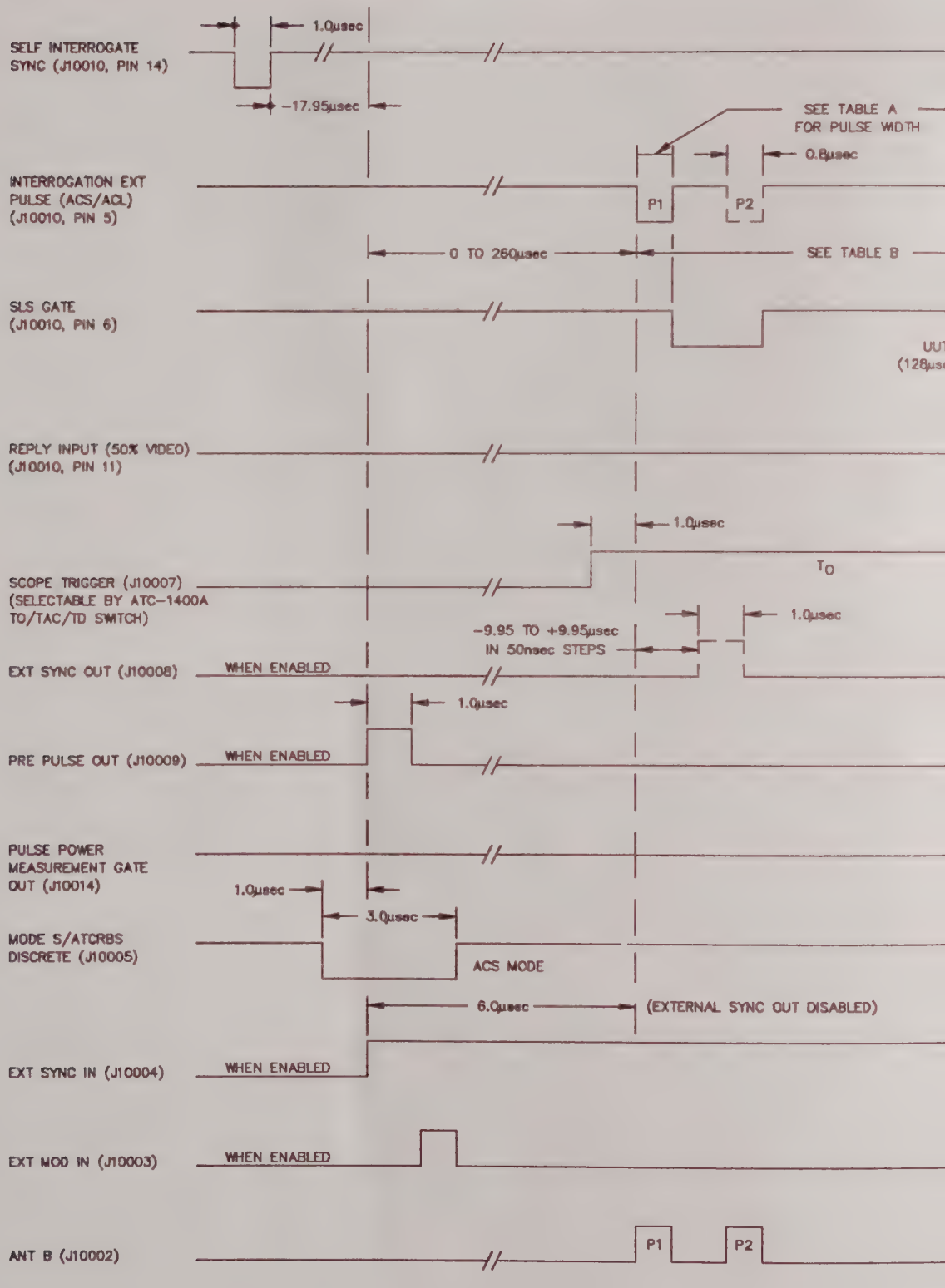
Ext.Mod.In:
- ON Disables the internal pulse generator.
- OFF Allows simultaneous internal/ external modulation.

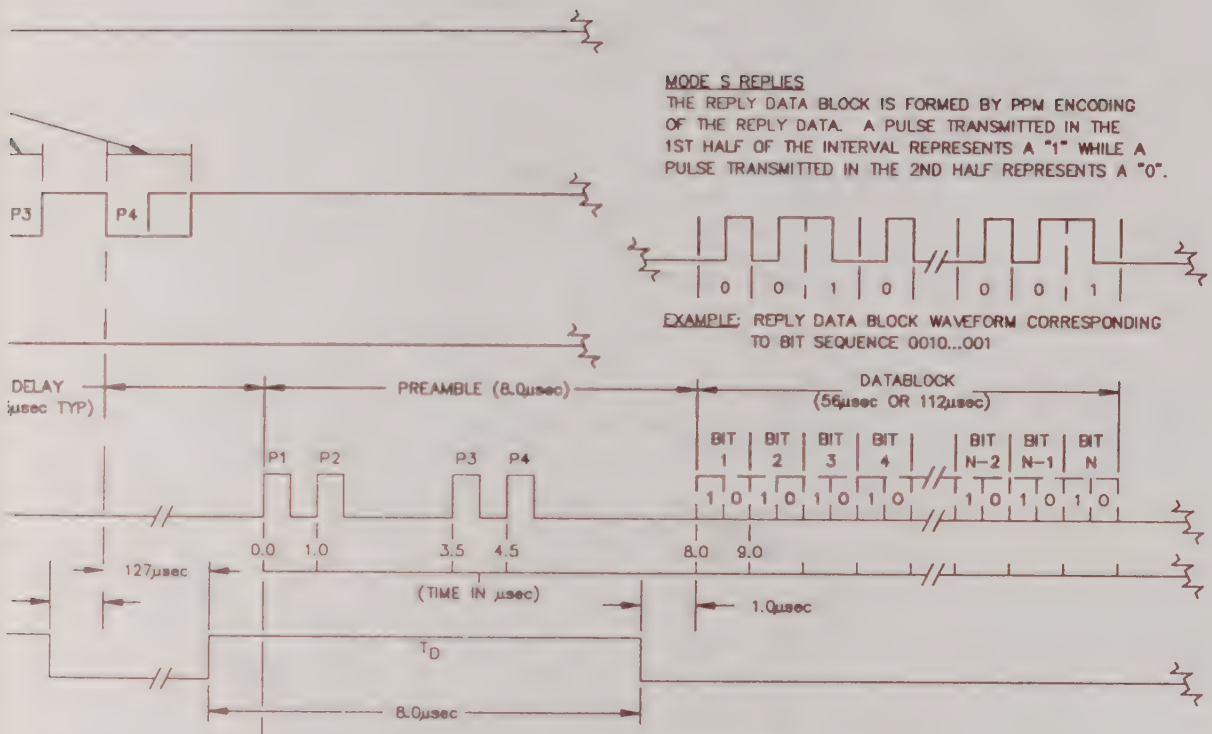
(4) Sequence Menu (Uplink/Downlink Format) Description

ACL Test Function does not utilize sequence menus.






SELF INTERROGATE SYNC (J10010, PIN 14)
1.0µsec
-17.95µsec
SEE TABLE A FOR PULSE WIDTH
0.8µsec
INTERROGATION EXT PULSE (ACS/ACL) (J10010, PIN 5)
P1
P2
0 TO 260µsec
SEE TABLE B
SLS GATE (J10010, PIN 6)
REPLY INPUT (50% VIDEO) (J10010, PIN 11)
1.0µsec
TO
SCOPE TRIGGER (J10007) (SELECTABLE BY ATC-1400A TO/TAC/TD SWITCH)
1.0µsec
-9.95 TO +9.95µsec IN 50nsec STEPS
EXT SYNC OUT (J10008)
WHEN ENABLED
1.0µsec
PRE PULSE OUT (J10009)
WHEN ENABLED
PULSE POWER MEASUREMENT GATE OUT (J10014)
1.0µsec
3.0µsec
MODE S/ATCRBS DISCRETE (J10005)
ACS MODE
6.0µsec
(EXTERNAL SYNC OUT DISABLED)
EXT SYNC IN (J10004)
WHEN ENABLED
EXT MOD IN (J10003)
WHEN ENABLED
ANT B (J10002)
P1
P2



MODE S REPLIES

THE REPLY DATA BLOCK IS FORMED BY PPM ENCODING OF THE REPLY DATA. A PULSE TRANSMITTED IN THE 1ST HALF OF THE INTERVAL REPRESENTS A "1" WHILE A PULSE TRANSMITTED IN THE 2ND HALF REPRESENTS A "0".

EXAMPLE: REPLY DATA BLOCK WAVEFORM CORRESPONDING TO BIT SEQUENCE 0010...001

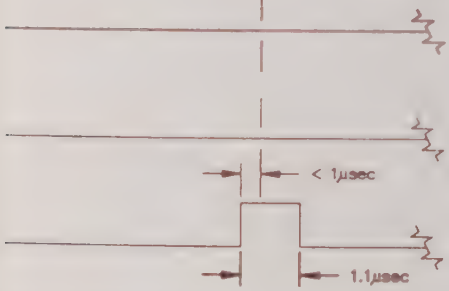


TABLE A (PULSE SHAPES)

THE PULSE SHAPES FOR PAM INTERROGATIONS ARE SUMMARIZED BELOW:

PULSE DESIGNATOR	PULSE DURATION (IN µsec)	DURATION TOLERANCE	RISE TIME MIN/MAX (IN µsec)	DECAY TIME MIN/MAX (IN µsec)
P1, P2, P3, P5	0.8	±0.1	0.05/0.1	0.05/0.2
P4 (SHORT)	0.8	±0.1	0.05/0.1	0.05/0.2
P4 (LONG)	1.6	±0.1	0.05/0.1	0.05/0.2

TABLE B: (PULSE PATTERNS)

THE PULSE PATTERNS OF THE PAM INTERROGATIONS ARE DEFINED BELOW:

INTERROGATION TYPE	SPACING (IN µsec)			
	P1–P2	P1–P3	P3–P4	P4
ATCRBS MODE A	2 ±0.15	8 ±0.2	–	NONE
ATCRBS MODE C	2 ±0.15	21 ±0.2	–	NONE
ATCRBS MODE A/MODE S ALL-CALL	2 ±0.15	8 ±0.2	2 ±0.05	LONG
ATCRBS MODE C/MODE S ALL-CALL	2 ±0.15	21 ±0.2	2 ±0.05	LONG
ATCRBS MODE A-ONLY ALL-CALL	2 ±0.15	8 ±0.2	2 ±0.05	SHORT
ATCRBS MODE C-ONLY ALL-CALL	2 ±0.15	21 ±0.2	2 ±0.05	SHORT

ACL/ACS Test Function Timing Chart
Figure 29

E. INTLCE Test Function

NOTE: S-1403 controls are identified by alphabetic character identifiers whereas all ATC-1400A controls are identified by numeric character identifiers.

NOTE: The following five items highlight INTLCE Test Function anomalies. Review these items and Appendix F prior to utilizing this test function.

The PRF rate (set by PRF/SQTR Thumbwheels [41]) is limited to 500 for a ratio of 1:3 or less, 400 for a ratio of 1:2, and 200 for a ratio of 1:1. The RATE ERROR message displays for the last two conditions only.

Reliable downlink information is displayed in Sequence Menus when the Interlace Ratio is 1:1. For all other ratios, downlink information appears randomly.

AP ERROR conditions will not be checked in this function.

Variable pulse controls are valid for the first (ATCRBS) interrogation only.

SLS/ECHO Thumbwheels (50) select amplitude of echo replies, P2 side-lobe suppression pulses and interference pulses.

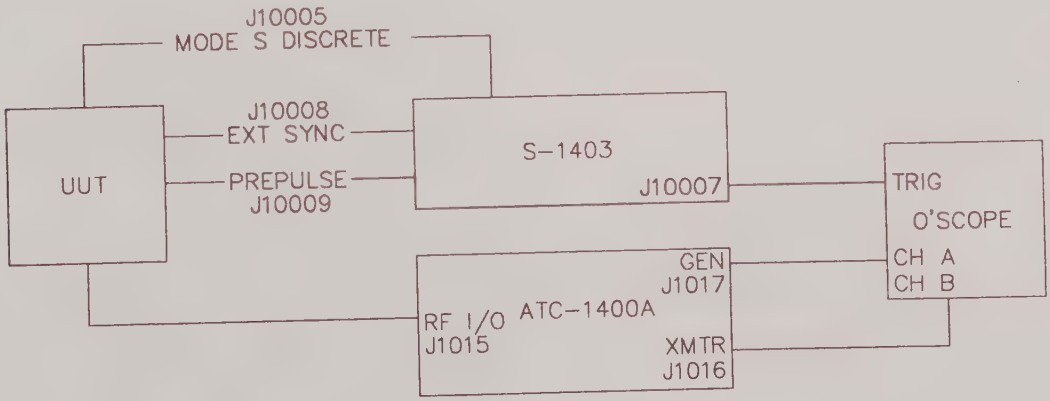


Figure 30 - INTLCE Test Function Hook-up Diagram

(1) Description of INTLCE Test Function.

Interlace function is used to add Mode S (SEQ) interrogations as a ratio of ATCRBS interrogations. Values can be set from 1 to 999. PRF/SQTR Thumbwheels (41) and PRF/SQTR ON/OFF Switch (32) control the PRF rate for interrogations. When the ratio is greater than 1:1 no sequence data is displayed in enabled sequence menus.

There is a 400 µs fixed delay from P_1 of the ATCRBS to P_1 of the Mode S. Variable pulse controls are valid for the first interrogation only.

NOTE: Only the first four enabled sequence items are used. Any additional enabled sequence items are not used.

(2) Control Menu #1 Display Description

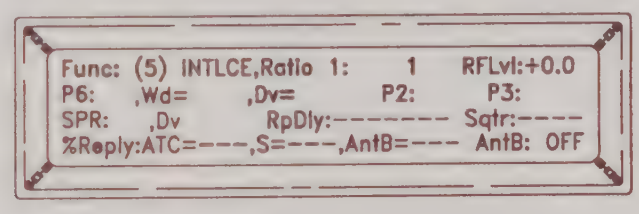


Figure 31 - INTLCE Control Menu #1

Func: (5)INTLCE,Ratio 1:

Selects the ratio of ATCRBS to Mode S interrogations. Ratio is set at 1 ATCRBS interrogation to (value selected) Mode S interrogations. Number of ATCRBS is shown after "Ratio 1:" field.

RFLvl: Adjustments for RF Levels in 0.1 dB steps (within a range of ±3.0 dB). RF adjustments are in addition to the level shown in RF LEVEL -dBm Display (3). Adjustments of 1 dB or greater should be accomplished utilizing SLEW Control (6).

P6: Not active in DI Test Function

P6:Wd= Not active in DI Test Function

P6:Dv= Not active in DI Test Function

P2: Not active in DI Test Function

P3:	Not active in DI Test Function
SPR:	Not active in DI Test Function
SPR:Dv:	Not active in DI Test Function
RpDly:	Displays measured reply delay for ATCRBS interrogations with 25 ns resolution and 50 ns accuracy. Displays Mode S replies when no ATCRBS reply is sent.
Sqtr:	Displays squitter period (transmission interval of a DF=11 downlink format) from 0.0 to 9.99 sec with 10 ms resolution.
%Reply:ATC=	Displays percent of ATCRBS replies only, from 0 to 127% in 1% steps. Does not display Mode S %Replies.
%Reply:S=	Displays percent of Mode S replies from 0 to 127% in 1% steps.
%Reply:AntB=	Displays percent of replies received from the ANT B connector, from 0 to 127% in 1% steps.
AntB:	OFF/(value). Enables or disables Channel B, the diversity generator. When enabled, a value from -0.95 µs to +0.95 µs can be selected as the delay from Channel A to Channel B in 0.05 µs steps.

(3) Control Menu #2 Display Definition

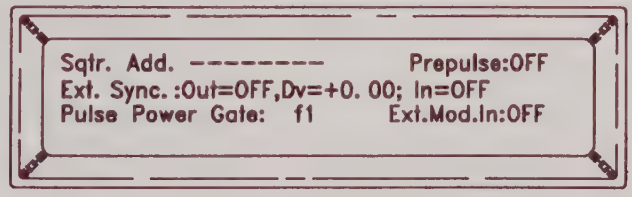


Figure 32 - INTLCE Control Menu #2

Sqtr.Add.:	24-bit octal value decoded from an unsolicited reply (squitter) on Channel A. This value is the Mode S Transponder address and is transmitted via Downlink Format.

Prepulse:	(0 to 260)/OFF control. The pulse can be positioned from 0 to 260 µs prior to the rising edge of P_1 of the interrogation in 1 µs steps.
Ext.Sync.:Out=	ON/OFF control for the external sync output function.
Ext.Sync.:Dv=	Deviation control for external sync, ranging from -9.95 µs to +9.95 µs in 50 ns steps.
Ext.Sync.:In=	ON/OFF control for external sync input control (positive TTL signal).
Pulse Power Gate:	Pulse power measurement gate tracks on reply delay and is selectable from P_1 to P_{116} (by input of a number from 1 to 116 or selected via SLEW Control [F]) and is not available for measuring the second reply. For all reply pulses, the measurement gate must be enabled prior to the rising edge of the pulse to be measured. The measurement will continue until the falling edge of the reply. For the S-1403 to control pulse power measurement requires F_2/P_2-F_1/P_1 Switch (34) be in the F_2/P_2 position. The F_1/P_1 position will measure the pulse power of an ATCRBS F_1 reply pulse only. The power measurement is performed in the ATC-1400A and displayed on XMTR PWR WATTS Display (1).
Ext.Mod.In:	ON Disables the internal pulse generator. OFF Allows simultaneous internal/external modulation.

(4) Sequence Menu (Uplink/Downlink) Description

(a) Sequence Menu S01 - Uplink/Downlink Format 00 (Short Special Surveillance)

The Mode S Test System queries the UUT designating the expected response definition (DF00 or DF16) in field RL. When RL field is set to 0, the response will be DF00 (short format reply) as shown in figure 33. RL field

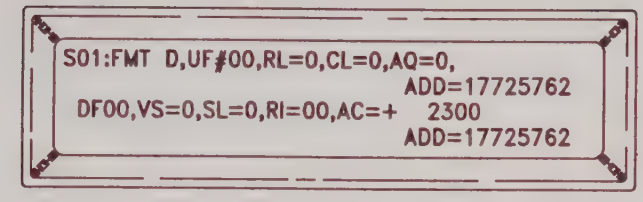


Figure 33 - Sequence Menu S01

equal to 1 declares DF16 (extended or long reply format) as the proper reply. Field CL is reserved for TCAS capable UUT's. When CL is zero, the default condition, TCAS has not generated a resolution advisory. A resolution advisory has been generated when CL is set to 1. AQ field is the command field for both UF00 and UF16. When AQ field is equal to zero (default condition for sequence menu S01), UF00 is the interrogation format. AQ field equal to 1 will direct UF16 to be the interrogation format.

Replies to the UUT, displayed as either DF00 or DF16, are determined by the value in field RL. Field VS determines the flight status of the UUT. Field AC represents the altitude related to the value in field VS. When VS is set to 1, representing an inflight condition, the value in AC symbolizes a flight altitude. VS field equal to 0 represents an on-ground condition and field VS symbolizes the airfield elevation. SL field reports TCAS sensitivity of the UUT to the interrogator (default is 0). Field RI is utilized to relay airspeed information to the interrogator. Codes 0 through 7 indicate an air-to-air non-acquisition reply. Codes 8 through 15 and an explanation of field SL are explained in Appendix E.

(b) Sequence Menu S02 - Uplink/Downlink Format 04 (Surveillance and Altitude Request)

Sequence Menu 02 PC= field mandates operating instructions to the UUT. Choices of selection in field PC= are non-selective All-Call lockout (1), cancel Comm-B (4), cancel Comm-C (5) or cancel Comm-D (6). Field RR instructs the UUT to reply in either short (codes 0 through 15) or long (codes 16 through 31) format. RR values of 16 through 31 will reply utilizing DF21. Field DI instructs the UUT to receive information

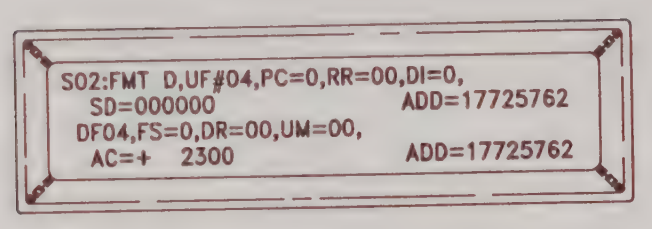


Figure 34 - Sequence Menu S02

contained in field SD. DI equal to 0 instructs the UUT to ignore all SD field data. When DI is set to 1, SD field is for multisite use. Setting DI to 7 will instruct the UUT to reply in extended field format (refer to Appendix E). Values of 2 through 6 are not defined.

Field FS reports flight status and alerts conditions (refer to Appendix E) to the interrogator. Field DR notifies the interrogator of the UUT's intent to transmit a message. A value of 0 represents no activity. When DR is equal to 1, the message will be Comm-B format. DR field values of 16 through 31 represent a Comm-D protocol message. Values of 2 through 15 are not defined. Field UM contains the transponder's status (refer to Appendix E) when DI is 1 and SD is XXXXAX (X represents any value, A represents any non-zero value). The status contains the identity of the interrogator and the Comm format for further communications. Field AC displays altitude in feet, unless the UUT is coded to reply in meters.

(c) Sequence Menu S03 - Uplink/Downlink Format 05 (Aircraft Identification Request)

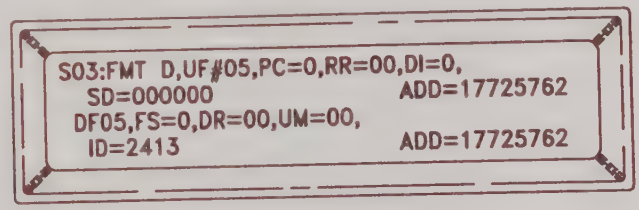


Figure 35 - Sequence Menu S03

Sequence Menu 03 PC= field mandates operating instructions to the UUT. Choices of selection in field PC= are non-selective All-Call lockout (1), cancel Comm-B (4), cancel Comm-C (5) or cancel Comm-D (6). Field RR= instructs the UUT to reply in either short (codes 0 through 15) or long (codes 16 through 31) format. RR= 16 through 31 will reply in DF21. Field DI instructs the UUT to receive information contained in field SD. DI equal to 0 instructs the UUT to ignore all SD field data. When DI is set to 1, SD field is for multisite use. Setting DI to 7 will instruct the UUT to reply in extended field format (refer to Appendix E). Values of 2 through 6 are not defined.

Field FS reports flight status and alerts conditions (refer to Appendix E) to the interrogator. Field DR notifies the interrogator of the UUT's intent to transmit a message. A value of 0 represents no activity. When DR is equal to 1, the message will be Comm-B format. DR field values of 16 through 31 represent a Comm-D protocol message. Values of 2 through 15 are not defined. Field UM contains the transponder's status (refer to Appendix E) when DI is 1 and SD is XXXXAX (X represents any value, A represents any non-zero value). The status contains the identity of the interrogator and the Comm format for further communications. Field ID contains the 4096 identification code set on the UUT.

(d) Sequence Menu S04 - Uplink/Downlink Format 11 (Mode S Only All-Call)

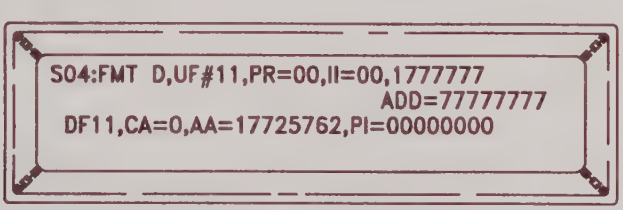


Figure 36 - Sequence Menu S04

Sequence Menu S04 PR field specifies the reply probability for replies from the UUT. This reply probability is used to separate replies in a saturated ATC environment. When PR field equals 0 or 8, the UUT replies normally. When PR is 5, 6, 7, 13, 14 or 15, the UUT is

instructed to not reply. Other PR field codes are contained in Appendix E. Field II identifies the interrogator for future All-Call lockouts. The seven digits after field II= is a constant value of 1777777.

Field CA notifies the interrogator of the UUT's capability to reply. When CA is 0, the UUT is unable to reply in extended formats (DF16 through 24). When CA is 1, the UUT can reply in Comm-A, Comm-B and extended formats. When CA is 2, the UUT can reply in Comm-A, Comm-B, Comm-C and extended formats. When CA is 3, the UUT can reply utilizing any Mode S format. Field AA contains the UUT address. This field should be equal to the uplink ADD field. PI= field contains the parity code overlaid on the interrogator's identity code.

(e) Sequence Menu S05 - Uplink/Downlink Format 16 (Long Special Surveillance)

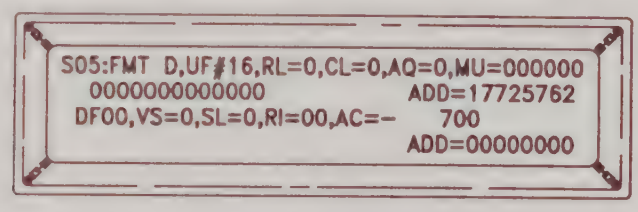


Figure 37 - Sequence Menu S05

The Mode S Test System queries the UUT designating the expected response definition (DF00 or DF16) in field RL. When RL field is set to 0, the response will be DF00 (short format reply) as shown in figure 37. RL field equal to 1 declares DF16 (extended or long reply format) as the proper reply. Field CL is reserved for TCAS capable UUT's. When CL is zero, the default condition, TCAS has not generated a resolution advisory. A resolution advisory has been generated when CL is set to 1. AQ field is the command field for both UF00 and UF16. When AQ field is equal to zero, UF00 is the interrogation format. AQ field equal to 1 (default condition for sequence menu S05) will direct UF16 to be the interrogation format. This sequence menu is dedicated for long (112 bit) responses for air-to-air requests. In responding to UF16, the UUT will reply with altitude and response format information.

Further communications will be through either unspecified long Downlink formats (22 or 23) or Downlink format 24. UF16 will not follow Comm-B formats. Field MU contains information used in air-to-air exchanges.

Replies to the UUT, displayed as either DF00 or DF16, are determined by the value in field RL. Field VS determines the flight status of the UUT. Field AC represents the altitude related to the value in field VS. When VS is set to 1, representing an in-flight condition, the value in AC symbolizes a flight altitude. VS field equal to 0 represents an on-ground condition and field VS symbolizes the airfield elevation. SL field reports TCAS sensitivity of the UUT to the interrogator (default is 0). Field RI is utilized to relay airspeed information to the interrogator. Codes 0 through 7 indicate an air-to-air non-acquisition reply. Codes 8 through 15 and an explanation of field SL are explained in Appendix E. Field MV contains information utilized in air-to-air exchanges and does not follow Comm-B format.

(f) Sequence Menu S06 - Uplink/Downlink Format 20 (Comm-A Altitude Request)

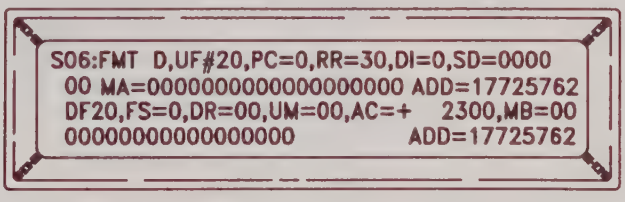


Figure 38 - Sequence Menu S06

Sequence Menu 06 PC field mandates operating instructions to the UUT. Choices of selection in field PC are non-selective All-Call lockout (1), cancel Comm-B (4), cancel Comm-C (5) or cancel Comm-D (6). Field RR= instructs the UUT to reply in either short (codes 0 through 15) or long (codes 16 through 31) format. RR= 16 through 31 will reply in DF21. Field DI instructs the UUT to receive information contained in field SD. DI equal to 0 instructs the UUT to ignore all SD field data. When DI is set to 1, SD field

is for multisite use. Setting DI to 7 will instruct the UUT to reply in extended field format (refer to Appendix E). Values of 2 through 6 are not defined. Field MA contains messages to the UUT and uses Comm-A format.

Field FS reports flight status and alerts conditions (refer to Appendix E) to the interrogator. Field DR notifies the interrogator of the UUT's intent to transmit a message. A value of 0 represents no activity. When DR is equal to 1, the message will be Comm-B format. DR field values of 16 through 31 represent a Comm-D protocol message. Values of 2 through 15 are not defined. Field UM contains the transponder's status (refer to Appendix E) when DI is 1 and SD is XXXXAX (X represents any value, A represents any non-zero value). The status contains the identity of the interrogator and the Comm format for further communications. Field AC displays altitude in feet, unless the UUT is coded to reply in meters. Field MB contains messages to the interrogator and uses Comm-B format.

(g) Sequence Menu S07 - Uplink/Downlink Format 21 (Comm-A Identity Request)

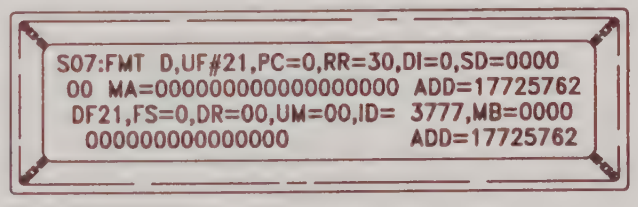
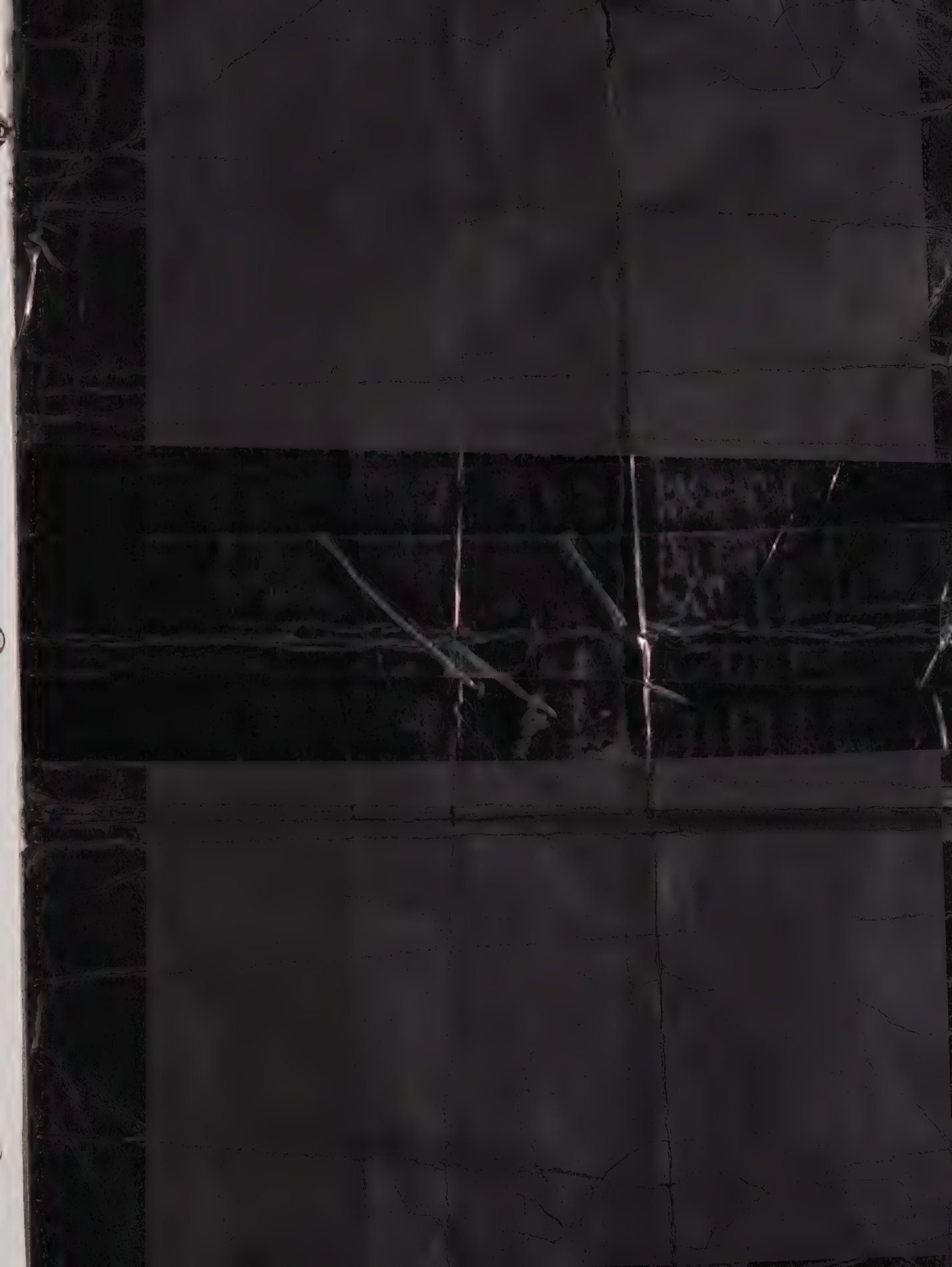
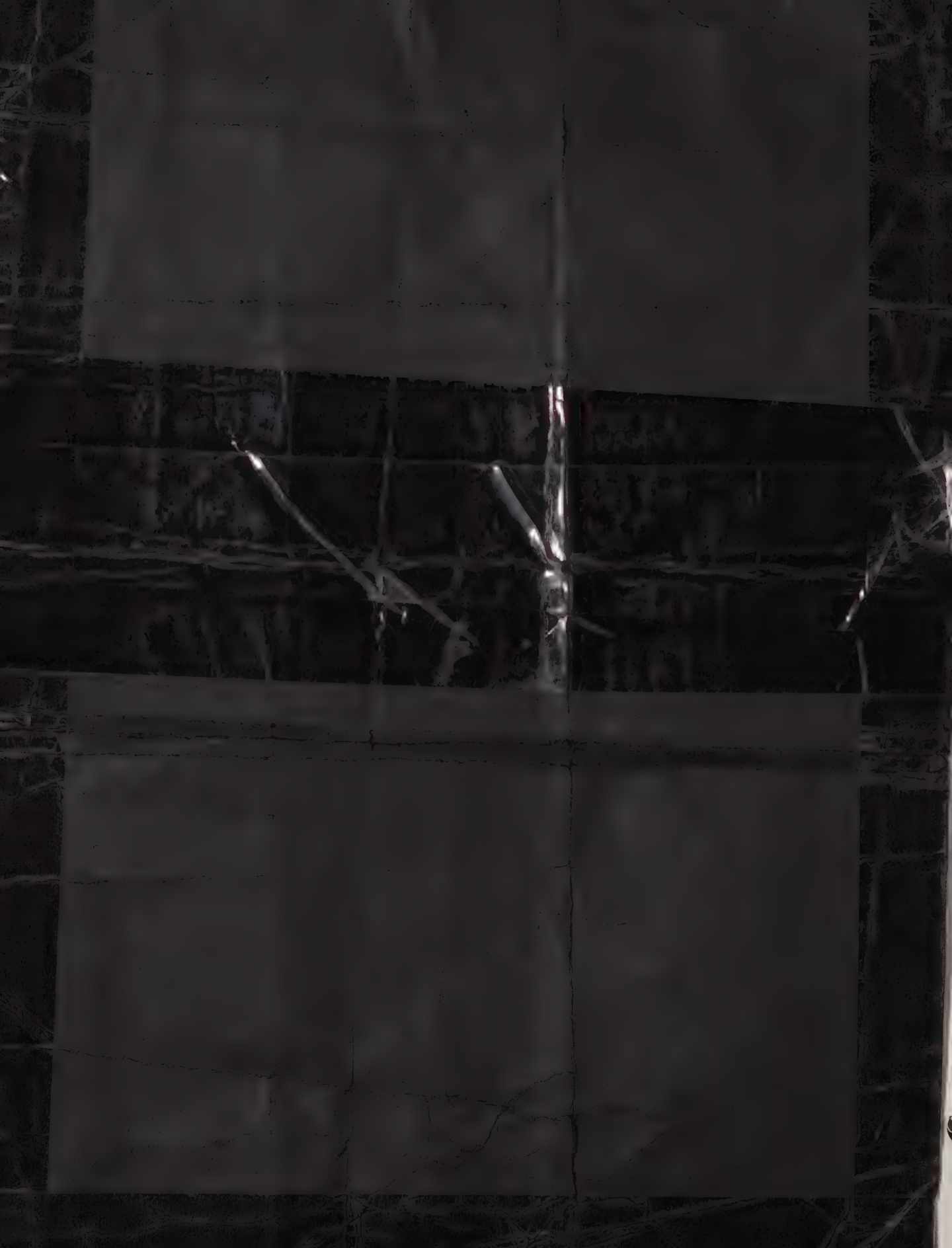


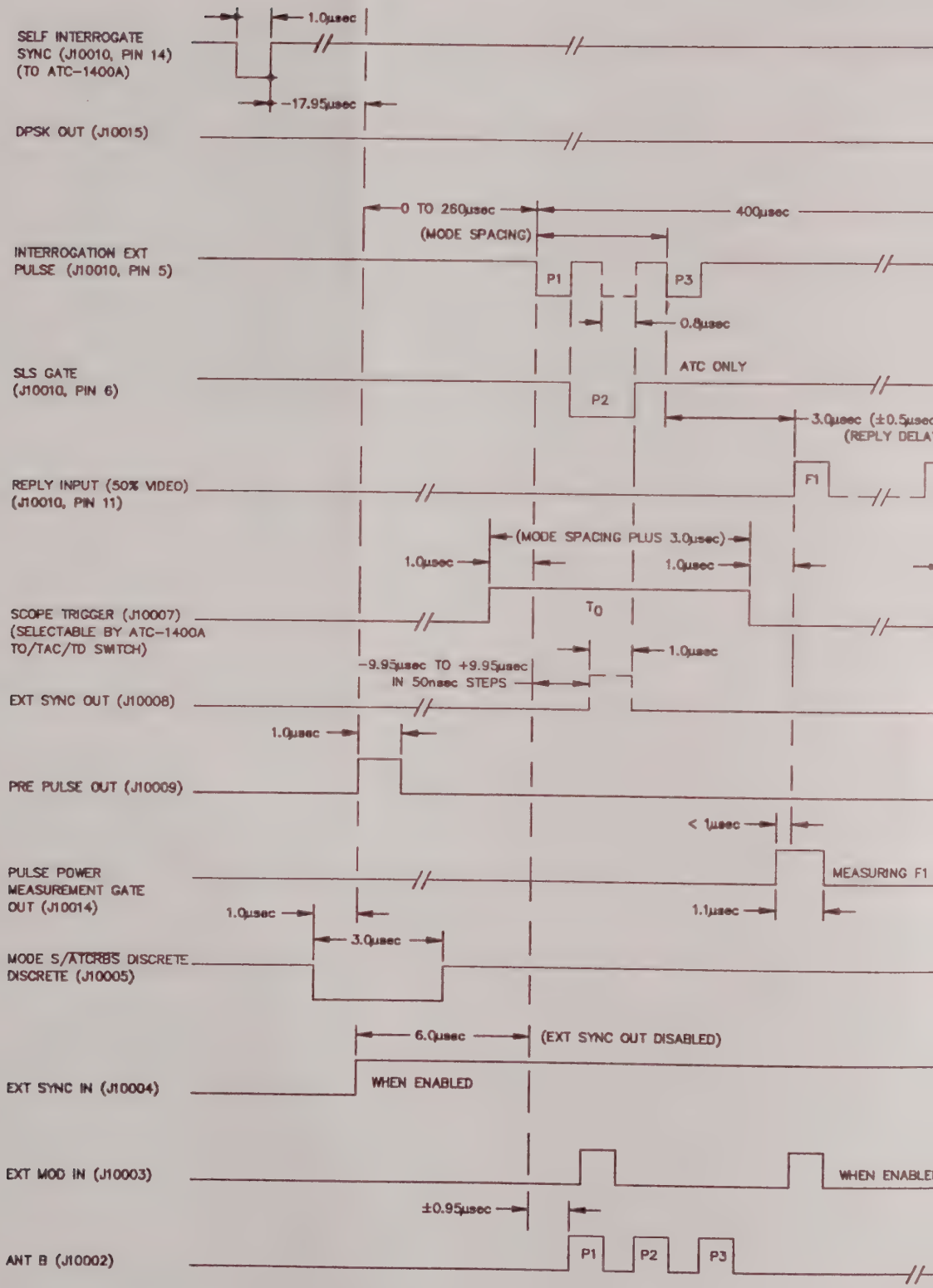
Figure 39 - Sequence Menu S07

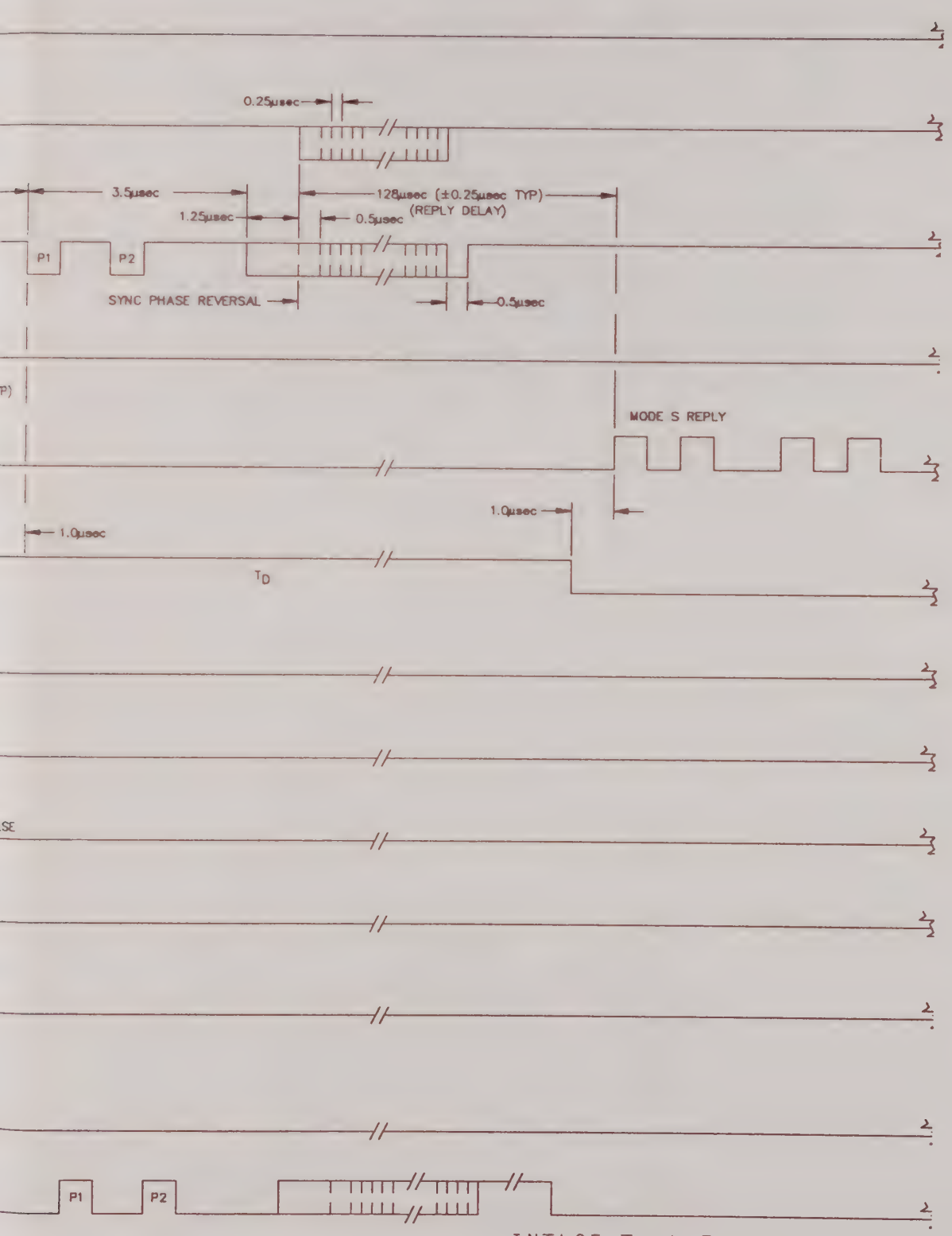
Sequence menu S07 PC= field mandates operating instructions to the UUT. Choices of selection in field PC= are non-selective All-Call lockout (1), cancel Comm-B (4), cancel Comm-C (5) or cancel Comm-D (6). Field RR instructs the UUT to reply in either short (codes 0 through 15) or long (codes 16 through 31) format. RR 16 through 31 will reply in DF21. Field DI instructs the UUT to receive information contained in field SD. DI equal to 0 instructs the UUT to ignore all SD field data. When DI is set to 1, SD field is for multisite use. Setting DI to 7 will instruct the UUT to reply in extended field format (refer to Appendix E). Values of 2 through 6 are not defined. Field MA contains messages from the interrogator to the UUT.

Field FS reports flight status and alerts conditions (refer to Appendix E) to the interrogator. Field DR notifies the interrogator of the UUT's intent to transmit a message. A value of 0 represents no activity. When DR is equal to 1, the message will be Comm-B format. DR field values of 16 through 31 represent a Comm-D protocol message. Values of 2 through 15 are not defined. Field UM contains the transponder's status (refer to Appendix E) when DI is 1 and SD is XXXXAX (X represents any value, A represents any non-zero value). The status contains the identity of the interrogator and the Comm format for further communications. ID contains the 4096 code selected on the front of the UUT. Field MB contains messages to the interrogator and uses Comm-B format.






1.0µsec
SELF INTERROGATE SYNC (J10010, PIN 14) (TO ATC-1400A)
-17.95µsec
DPSK OUT (J10015)
0 TO 260µsec
400µsec
(MODE SPACING)
INTERROGATION EXT PULSE (J10010, PIN 5)
P1
P3
0.8µsec
SLS GATE (J10010, PIN 6)
ATC ONLY
P2
3.0µsec (±0.5µsec
(REPLY DELA
REPLY INPUT (50% VIDEO) (J10010, PIN 11)
F1
(MODE SPACING PLUS 3.0µsec)
1.0µsec
1.0µsec
SCOPE TRIGGER (J10007) (SELECTABLE BY ATC-1400A TO/TAC/TD SWITCH)
T0
1.0µsec
-9.95µsec TO +9.95µsec IN 50nsec STEPS
EXT SYNC OUT (J10008)
1.0µsec
PRE PULSE OUT (J10009)
< 1µsec
PULSE POWER MEASUREMENT GATE OUT (J10014)
MEASURING F1
1.0µsec
1.1µsec
3.0µsec
MODE S/ATCRBS DISCRETE DISCRETE (J10005)
6.0µsec
(EXT SYNC OUT DISABLED)
EXT SYNC IN (J10004)
WHEN ENABLED
EXT MOD IN (J10003)
WHEN ENABLE
±0.95µsec
ANT B (J10002)
P1
P2
P3



INTLCE Test Function Timing Chart
Figure 40

F. DI Test Function

NOTE: S-1403 controls are identified by alphabetic character identifiers whereas all ATC-1400A controls are identified by numeric character identifiers.

NOTE: The following eight items highlight DI Test Function anomalies. Review these items and Appendix F prior to utilizing this test function.

The PRF rate set by PRF/SQTR Thumbwheel (41) is limited to 750 with replies (RATE ERROR message occurs) occurring for the ATC;ATC configuration and 500 without replies (no error message indicated). For all other configurations, the PRF limit is 100.

DBL INTERR/INTERF PULSE Thumbwheels (42) must be set DOUBLE.

XPDR MODE Control (38) is used to determine the mode used for both the first and second interrogations for ATC, ACS, and ACL functions.

If no reply is detected for the first interrogation, the Reply Delay may not be accurate.

There is no Pulse Measurement capability for the reply to the second interrogation.

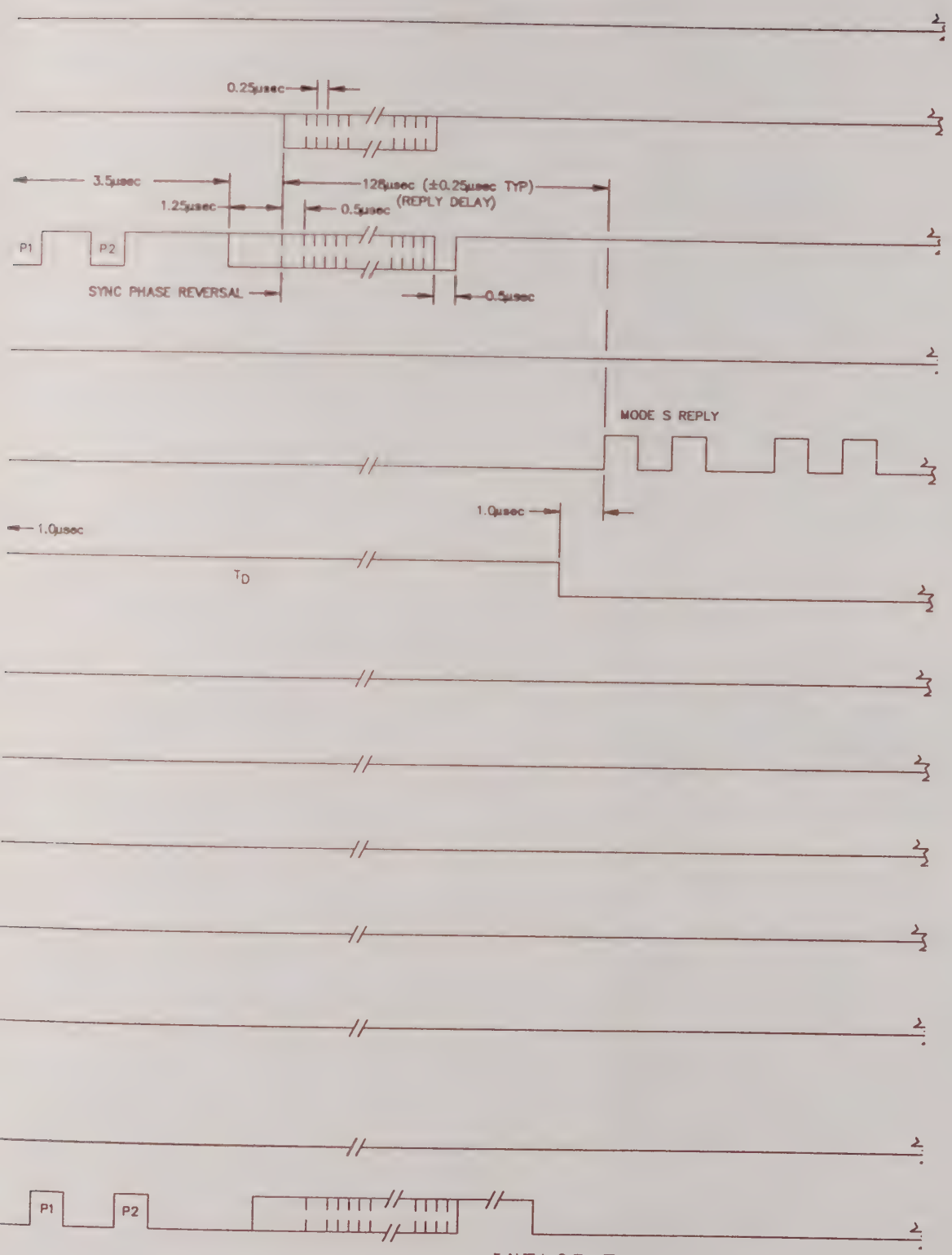
ATC-1400A % REPLY Display (46) is invalid.

If the second interrogation occurs before the first reply (DBL INTERR/INTERF spacing is less than the expected reply delay), the reply delay will be invalid.

EXT SYNC (J10008) is not operational in this function.

(1) Description of DI Test Function.

The Double Interrogation function allows the user to generate a dual interrogation consisting of any combination of ATCRBS or Mode S. More specifically, the selections for the first and second interrogations are: "ATC", "SEQ", "ACS", or "ACL". DBL INTERR/INTERF PULSE Thumbwheels (42) control the spacing between interrogations (ref. Table 1, Para. 1-2-2). PRF/SQTR Thumbwheels (41) and PRF/SQTR ON/OFF Switch (32) control the PRF rate of the interrogations.



INTLCE Test Function Timing Chart
Figure 40

F. DI Test Function

NOTE: S-1403 controls are identified by alphabetic character identifiers whereas all ATC-1400A controls are identified by numeric character identifiers.

NOTE: The following eight items highlight DI Test Function anomalies. Review these items and Appendix F prior to utilizing this test function.

The PRF rate set by PRF/SQTR Thumbwheel (41) is limited to 750 with replies (RATE ERROR message occurs) occurring for the ATC;ATC configuration and 500 without replies (no error message indicated). For all other configurations, the PRF limit is 100.

DBL INTERR/INTERF PULSE Thumbwheels (42) must be set DOUBLE.

XPDR MODE Control (38) is used to determine the mode used for both the first and second interrogations for ATC, ACS, and ACL functions.

If no reply is detected for the first interrogation, the Reply Delay may not be accurate.

There is no Pulse Measurement capability for the reply to the second interrogation.

ATC-1400A % REPLY Display (46) is invalid.

If the second interrogation occurs before the first reply (DBL INTERR/INTERF spacing is less than the expected reply delay), the reply delay will be invalid.

EXT SYNC (J10008) is not operational in this function.

(1) Description of DI Test Function.

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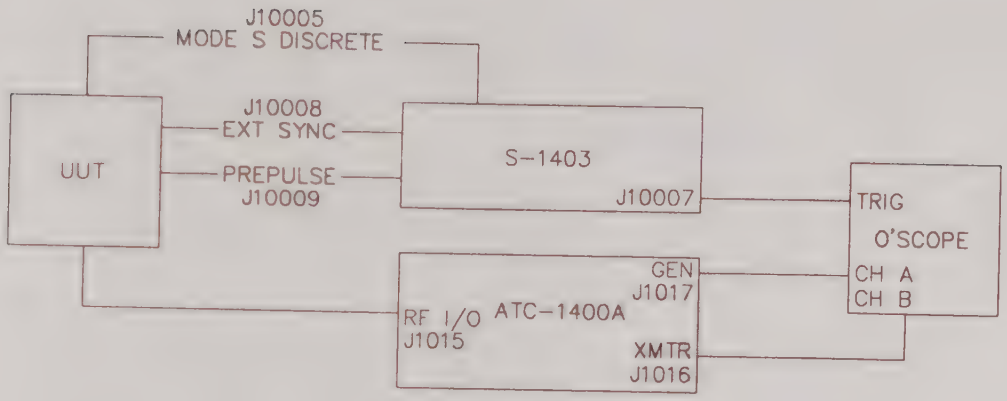


Figure 41 - DI Test Function Hook-up Diagram

Double Interrogation (DI) requires DBL INTERR/INTERF PULSE Thumbwheels (42) set to DOUBLE. The S-1403 generates both the first and second interrogation and can generate any combination of Mode S, All Call or ATCRBS interrogations. Variable pulse control is valid for the first interrogation only.

NOTE: Replies and interrogations can be overlaid if delay between interrogations is too short.

(2) Control Menu #1 Display Definition

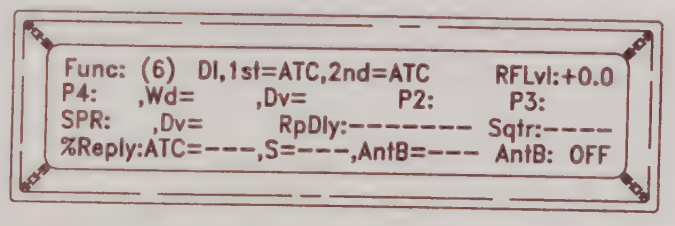


Figure 42 - DI Control Menu #1

Func:(6)DI,1st=,2nd=

Interrogations are selected utilizing the two sub-fields within this field. 1st= field is selected utilizing XPDR MODE Control (38). 2nd= field is selected by placing the cursor in this field and rotating SLEW Control (F) until the requested mode is selected. The mode set by XPDR MODE Control (38) for the first interrogation will be the mode used to program the second function during ACS or ACL operations.

NOTE: Only the first four enabled sequence items will be used.

RFLvl: Adjustments for RF Levels in 0.1 dB steps (within a range of ±3.0 dB). RF adjustments are in addition to the level shown in RF LEVEL -dBm Display (3). Adjustments of 1 dB or greater should be accomplished utilizing SLEW Control (6).

P4: Not active in DI Test Function.

P4:Wd= Not active in DI Test Function.

P4:Dv= Not active in DI Test Function.

P2: Not active in DI Test Function.

P3: Not active in DI Test Function.

SPR: Not active in DI Test Function.

SPR:,Dv= Not active in DI Test Function.

RpDly: (Valid for first interrogation only.) Displays measured reply delay for ATCRBS interrogations (typically 3.0 µs) or Mode S interrogations (typically 128 µs) with 25 ns resolution and 50 ns accuracy.

Sqtr: Displays squitter period (transmission interval of a DF=11 downlink format) from 0.0 to 9.99 sec with 10 ms resolution.

%Reply:ATC= Displays percent of ATCRBS replies only, from 0 to 127 in 1% steps.

%Reply:S= Displays percent of valid Mode S replies only, from 0 to 127 in 1% steps.

%Reply:AntB= Displays percent of replies received from the ANT B Connector, from 0 to 127 in 1% steps. ANT A input must be operational for ANT B to be operational.

AntB: OFF/(delay value). Enables or disables Channel B, the diversity generator. When enabled, a value from -0.95 µs to +0.95 µs can be selected as the delay from Channel A to Channel B in 0.05 µs steps.

(3) Control Menu #2 Display Definition

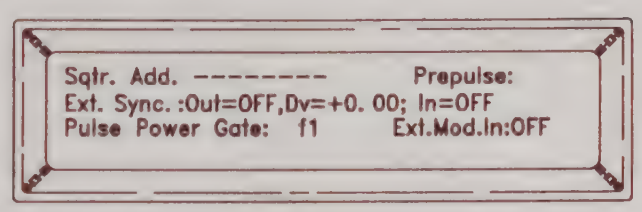


Figure 43 - DI Control Menu #2

Sqtr.Add. — 24-bit octal value decoded from an unsolicited reply (squitter) on ANT A. This value is the Mode S Transponder's address and is transmitted via Downlink Format.

Prepulse: — Not active in DI Test Function.

Ext.Sync.:Out= — ON/OFF control for the external sync output function.

Ext.Sync.:Dv= — Deviation control for external sync output, ranging from -9.95 µs to +9.95 µs in 50 ns steps.

Ext.Sync.:In= — ON/OFF control for external sync input control (positive TTL signal).

Pulse Power Gate: — Pulse power measurement gate tracks on the reply delay and is selectable from P_1 to P_{116} (by input of a number from 1 to 116 or selected via SLEW Control [F]) and is not available for the second pulse.

For all reply pulses, the measurement gate will be enabled prior to the rising edge of the pulse and continue measuring until falling edge. In the case of Mode S replies, since they are in PPM format, care should be taken to ensure the data pulses prior to and following the pulse to be measured are such that their power levels will not be measured as well. For example: to measure P_6 power; If P_6 is "0", then P_5 state doesn't matter and P_7 should be a "0". If P_6 is a "1", then P_5 should

be a "1" and P_7 state doesn't matter. If P_5 were "0" and P_6 a "1", no rising edge would be detected and therefore the power reading would be zero.

For the S-1403 to control pulse power measurement F_2/P_2-F_1/P_1 Switch (34) must be in the F_2/P_2 position. The F_1/P_1 position will measure the pulse power of an ATCRBS F_1 reply pulse only. The power measurement is performed in the ATC-1400A and displayed on XMTR PWR WATTS Display (1).

Ext.Mod.In: ON Disables the internal pulse generator.
OFF Allows simultaneous internal /external modulation.

(4) Sequence Menu (Uplink/Downlink) Description

(a) Sequence Menu S01 - Uplink/Downlink Format 00 (Short Special Surveillance)

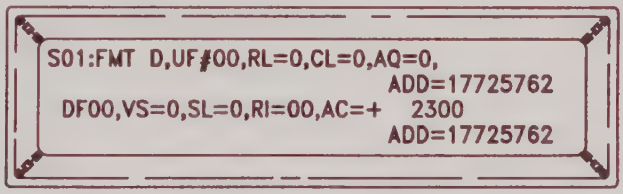


Figure 44 - Sequence Menu S01

The Mode S Test System queries the UUT designating the expected response definition (DF00 or DF16) in field RL. When RL field is set to 0, the response will be DF00 (short format reply) as shown in figure 44. RL field equal to 1 declares DF16 (extended or long reply format) as the proper reply. Field CL is reserved for TCAS capable UUT's. When CL is zero, the default condition, TCAS has not generated a resolution advisory. A resolution advisory has been generated when CL is set to 1. AQ field is the command field for both UF00 and UF16. When AQ field is equal to zero (default condition for sequence menu S01), UF00 is the interrogation format. AQ field equal to 1 will direct UF16 to be the interrogation format.

Replies to the UUT, displayed as either DF00 or DF16, are determined by the value in field RL. Field VS determines the flight status of the UUT. Field AC represents the altitude related to the value in field VS. When VS is set to 1, representing an in-flight condition, the value in AC symbolizes a flight altitude. VS field equal to 0 represents an on-ground condition and field VS symbolizes the airfield elevation. SL field reports TCAS sensitivity of the UUT to the interrogator (default is 0). Field RI is utilized to relay airspeed information to the interrogator. Codes 0 through 7 indicate an air-to-air non-acquisition reply. Codes 8 through 15 and an explanation of field SL are explained in Appendix E.

(b) Sequence Menu S02 - Uplink/Downlink Format 04 (Surveillance and Altitude Request)

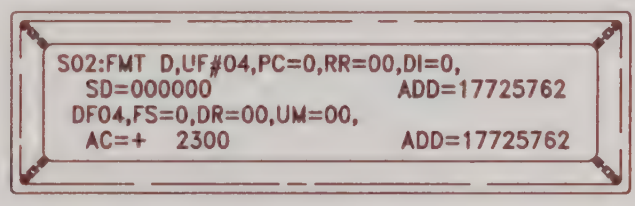


Figure 45 - Sequence Menu S02

Sequence Menu 02 PC= field mandates operating instructions to the UUT. Choices of selection in field PC= are non-selective All-Call lockout (1), cancel Comm-B (4), cancel Comm-C (5) or cancel Comm-D (6). Field RR instructs the UUT to reply in either short (codes 0 through 15) or long (codes 16 through 31) format. RR values of 16 through 31 will reply utilizing DF21. Field DI instructs the UUT to receive information contained in field SD. DI equal to 0 instructs the UUT to ignore all SD field data. When DI is set to 1, SD field is for multisite use. Setting DI to 7 will instruct the UUT to reply in extended field format (refer to Appendix E). Values of 2 through 6 are not defined.

Field FS reports flight status and alerts conditions (refer to Appendix E) to the interrogator. Field DR notifies the interrogator of the UUT's intent to transmit a message. A value of 0 represents no activity. When DR is equal to 1, the message will be Comm-B format. DR field values of 16

through 31 represent a Comm-D protocol message. Values of 2 through 15 are not defined. Field UM contains the transponder's status (refer to Appendix E) when DI is 1 and SD is XXXXAX (X represents any value, A represents any non-zero value). The status contains the identity of the interrogator and the Comm format for further communications. Field AC displays altitude in feet, unless the UUT is coded to reply in meters.

(c) Sequence Menu S03 - Uplink/Downlink Format 05 (Aircraft Identification Request)

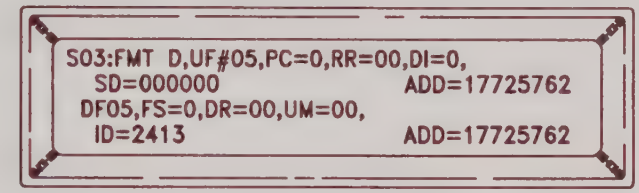


Figure 46 - Sequence Menu S03

Sequence Menu 03 PC= field mandates operating instructions to the UUT. Choices of selection in field PC= are non-selective All-Call lockout (1), cancel Comm-B (4), cancel Comm-C (5) or cancel Comm-D (6). Field RR= instructs the UUT to reply in either short (codes 0 through 15) or long (codes 16 through 31) format. RR= 16 through 31 will reply in DF21. Field DI instructs the UUT to receive information contained in field SD. DI equal to 0 instructs the UUT to ignore all SD field data. When DI is set to 1, SD field is for multisite use. Setting DI to 7 will instruct the UUT to reply in extended field format (refer to Appendix E). Values of 2 through 6 are not defined.

Field FS reports flight status and alerts conditions (refer to Appendix E) to the interrogator. Field DR notifies the interrogator of the UUT's intent to transmit a message. A value of 0 represents no activity. When DR is equal to 1, the message will be Comm-B format. DR field values of 16 through 31 represent a Comm-D protocol message. Values of 2 through 15 are not defined. Field UM contains the transponder's status (refer to Appendix E) when DI is 1 and SD is XXXXAX (X represents any value, A

represents any non-zero value). The status contains the identity of the interrogator and the Comm format for further communications. Field ID contains the 4096 identification code set on the UUT.

(d) Sequence Menu S04 - Uplink/Downlink Format 11 (Mode S Only All-Call)

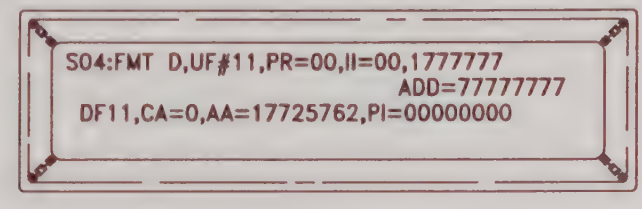


Figure 47 - Sequence Menu S04

Sequence Menu S04 PR field specifies the reply probability for replies from the UUT. This reply probability is used to separate replies in a saturated ATC environment. When PR field equals 0 or 8, the UUT replies normally. When PR is 5, 6, 7, 13, 14 or 15, the UUT is instructed to not reply. Other PR field codes are contained in Appendix E. Field II identifies the interrogator for future All-Call lockouts. The seven digits after field II= is a constant value of 1777777.

Field CA notifies the interrogator of the UUT's capability to reply. When CA is 0, the UUT is unable to reply in extended formats (DF16 through 24). When CA is 1, the UUT can reply in Comm-A, Comm-B and extended formats. When CA is 2, the UUT can reply in Comm-A, Comm-B, Comm-C and extended formats. When CA is 3, the UUT can reply utilizing any Mode S format. Field AA contains the UUT address. This field should be equal to the uplink ADD field. PI= field contains the parity code overlaid on the interrogator's identity code.

(e) Sequence Menu S05 - Uplink/Downlink Format 16 (Long Special Surveillance)

The Mode S Test System queries the UUT designating the expected response definition (DF00 or DF16) in field RL. When RL field is set to 0, the response will be DF00 (short format reply) as shown in figure 48. RL field equal to 1 declares DF16 (extended or long reply format) as the proper reply. Field CL is reserved for TCAS capable UUT's. When CL is zero, the default condition, TCAS has not

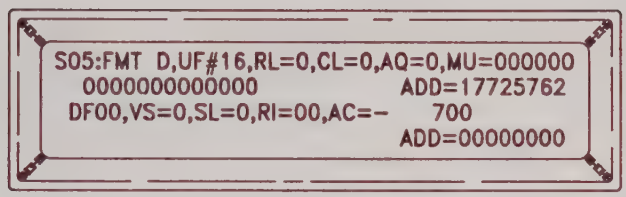


Figure 48 - Sequence Menu S05

generated a resolution advisory. A resolution advisory has been generated when CL is set to 1. AQ field is the command field for both UF00 and UF16. When AQ field is equal to zero, UF00 is the interrogation format. AQ field equal to 1 (default condition for sequence menu S05) will direct UF16 to be the interrogation format. This sequence menu is dedicated for long (112 bit) responses for air-to-air requests. In responding to UF16, the UUT will reply with altitude and response format information. Further communications will be through either unspecified long Downlink formats (22 or 23) or Downlink format 24. UF16 will not follow Comm-B formats. Field MU contains information used in air-to-air exchanges.

Replies to the UUT, displayed as either DF00 or DF16, are determined by the value in field RL. Field VS determines the flight status of the UUT. Field AC represents the altitude related to the value in field VS. When VS is set to 1, representing an in-flight condition, the value in AC symbolizes a flight altitude. VS field equal to 0 represents an on-ground condition and field VS symbolizes the airfield elevation. SL field reports TCAS sensitivity of the UUT to the interrogator (default is 0). Field RI is utilized to relay airspeed information to the interrogator. Codes 0 through 7 indicate an air-to-air non-acquisition reply. Codes 8 through 15 and an explanation of field SL are explained in Appendix E. Field MV contains information utilized in air-to-air exchanges and does not follow Comm-B format.

(f) Sequence Menu S06 - Uplink/Downlink Format 20 (Comm-A Altitude Request)

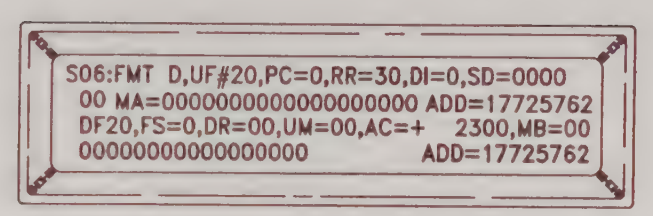


Figure 49 - Sequence Menu S06

Sequence Menu 06 PC field mandates operating instructions to the UUT. Choices of selection in field PC are non-selective All-Call lockout (1), cancel Comm-B (4), cancel Comm-C (5) or cancel Comm-D (6). Field RR= instructs the UUT to reply in either short (codes 0 through 15) or long (codes 16 through 31) format. RR= 16 through 31 will reply in DF21. Field DI instructs the UUT to receive information contained in field SD. DI equal to 0 instructs the UUT to ignore all SD field data. When DI is set to 1, SD field is for multisite use. Setting DI to 7 will instruct the UUT to reply in extended field format (refer to Appendix E). Values of 2 through 6 are not defined. Field MA contains messages to the UUT and uses Comm-A format.

Field FS reports flight status and alerts conditions (refer to Appendix E) to the interrogator. Field DR notifies the interrogator of the UUT's intent to transmit a message. A value of 0 represents no activity. When DR is equal to 1, the message will be Comm-B format. DR field values of 16 through 31 represent a Comm-D protocol message. Values of 2 through 15 are not defined. Field UM contains the transponder's status (refer to Appendix E) when DI is 1 and SD is XXXXAX (X represents any value, A represents any non-zero value). The status contains the identity of the interrogator and the Comm format for further communications. Field AC displays altitude in feet, unless the UUT is coded to reply in meters. Field MB contains messages to the interrogator and uses Comm-B format.

(g) Sequence Menu S07 - Uplink/Downlink Format 21 (Comm-A Identity Request)

Sequence menu S07 PC= field mandates operating instructions to the UUT. Choices of selection in field PC= are non-selective All-Call lockout (1), cancel Comm-B (4), cancel Comm-C (5) or cancel Comm-D (6). Field RR instructs the UUT to

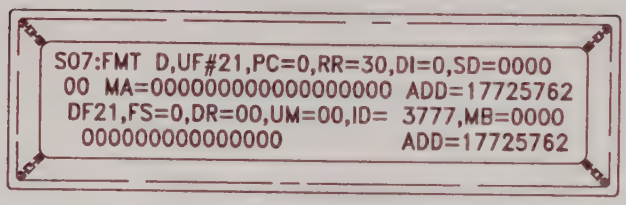
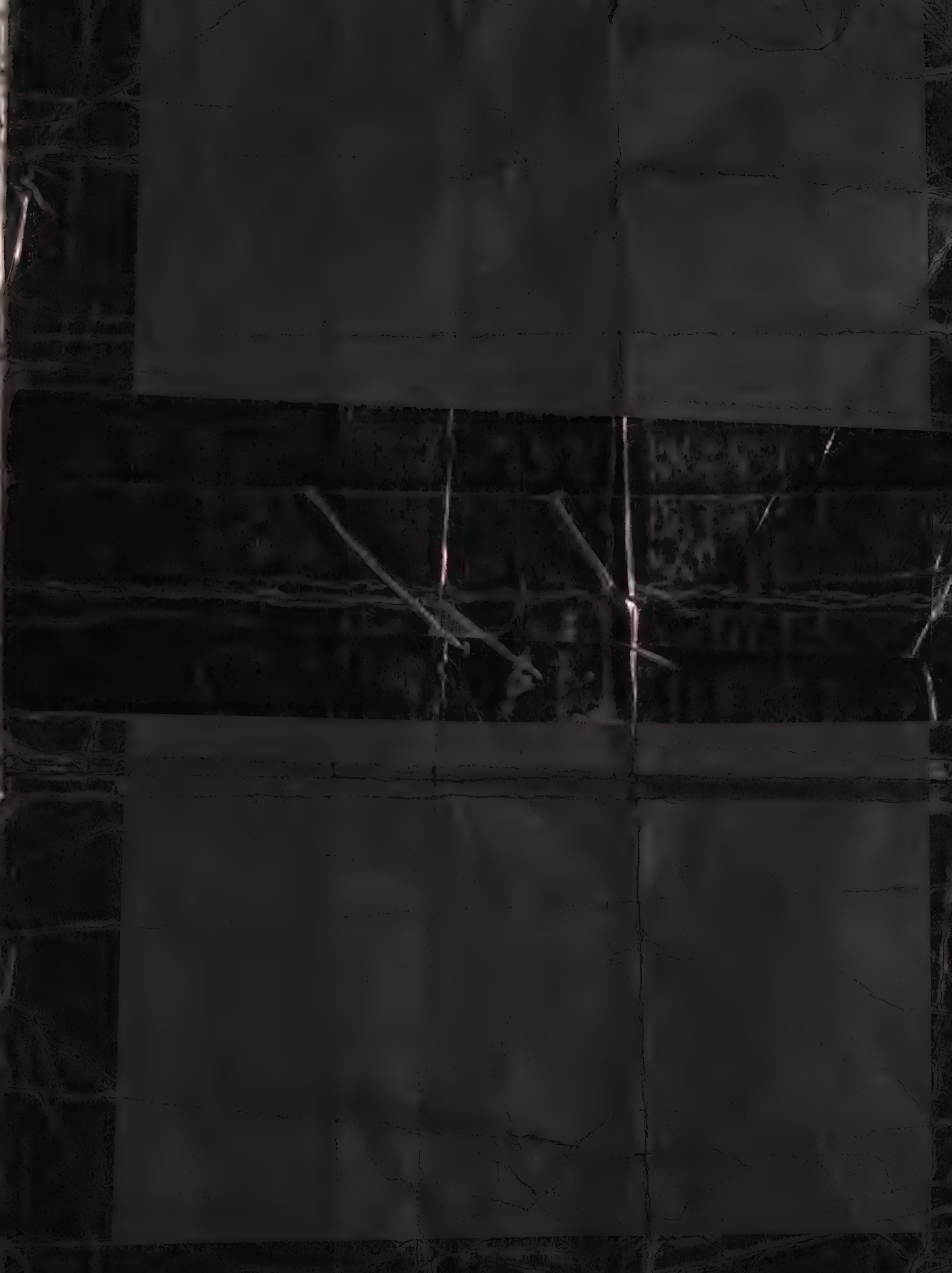
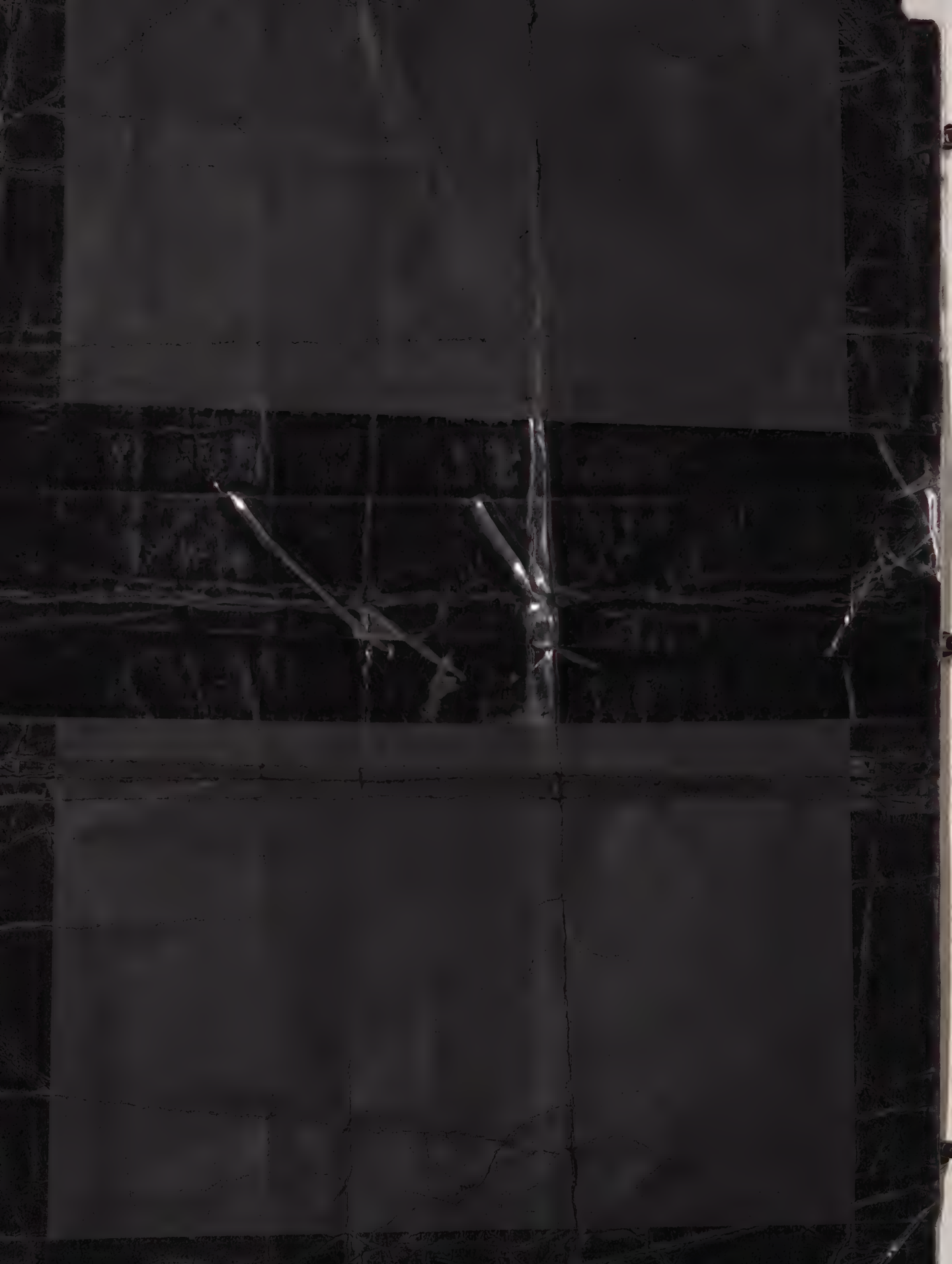


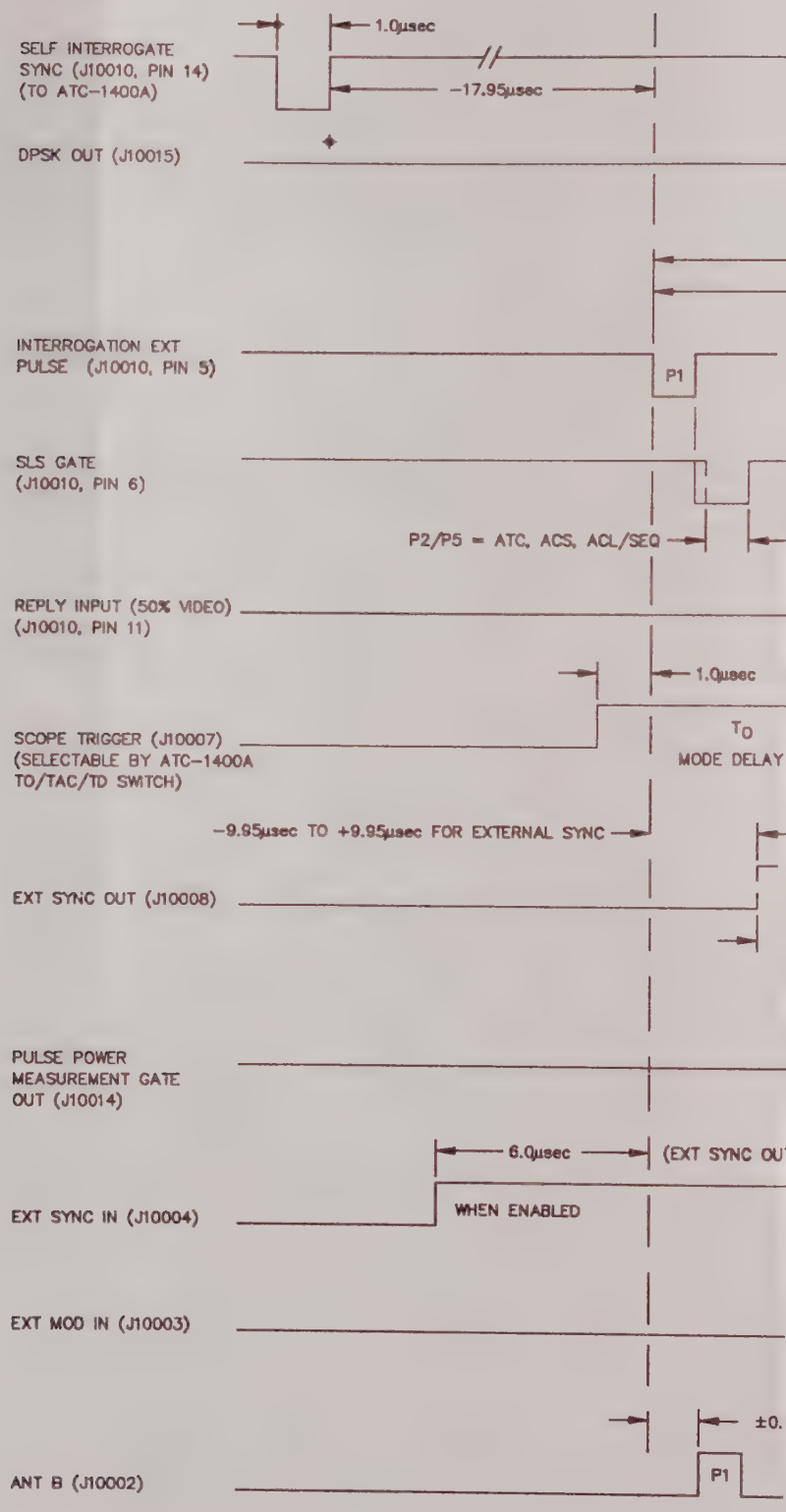
Figure 50 - Sequence Menu S07

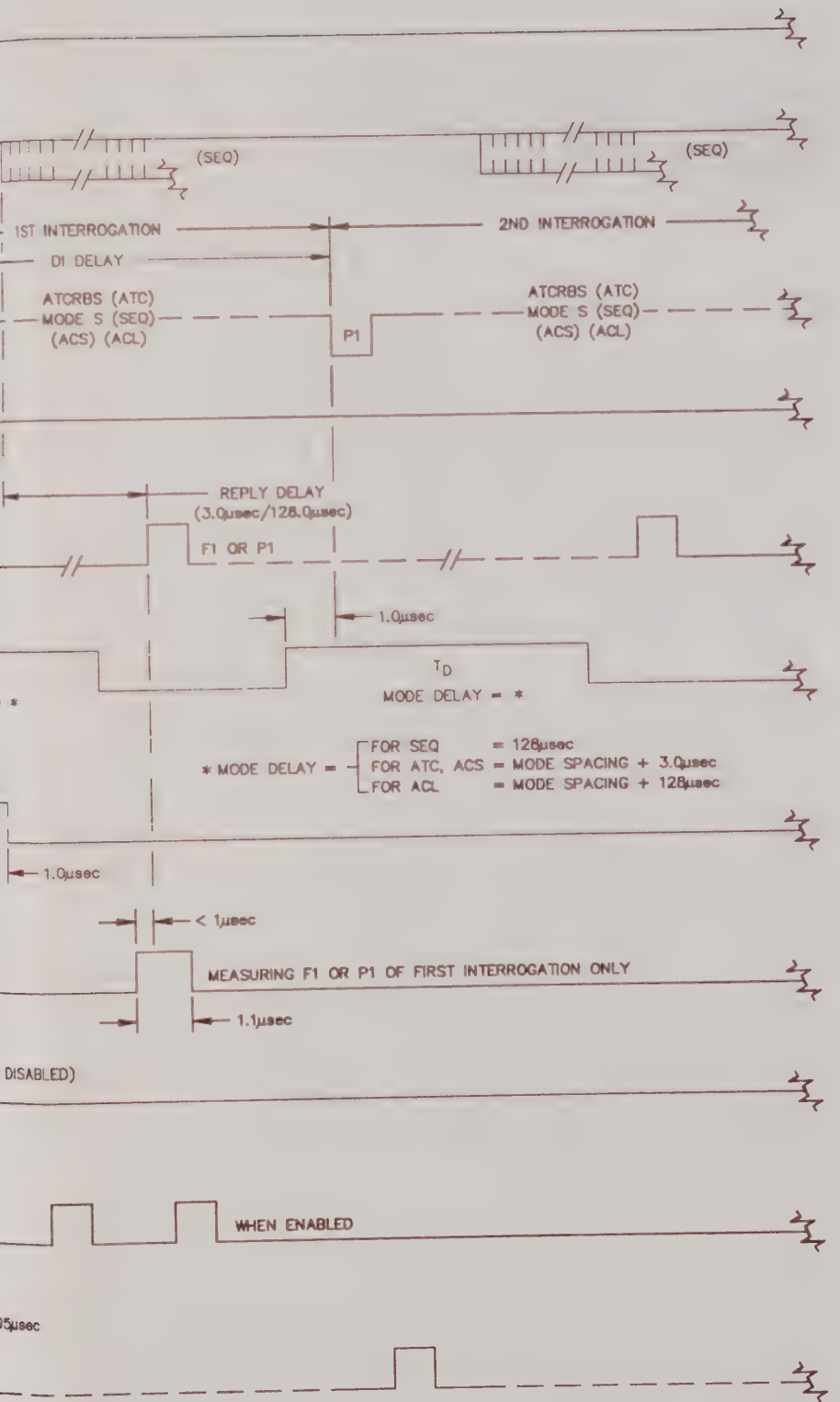
reply in either short (codes 0 through 15) or long (codes 16 through 31) format. RR 16 through 31 will reply in DF21. Field DI instructs the UUT to receive information contained in field SD. DI equal to 0 instructs the UUT to ignore all SD field data. When DI is set to 1, SD field is for multisite use. Setting DI to 7 will instruct the UUT to reply in extended field format (refer to Appendix E). Values of 2 through 6 are not defined. Field MA contains messages from the interrogator to the UUT.

Field FS reports flight status and alerts conditions (refer to Appendix E) to the interrogator. Field DR notifies the interrogator of the UUT's intent to transmit a message. A value of 0 represents no activity. When DR is equal to 1, the message will be Comm-B format. DR field values of 16 through 31 represent a Comm-D protocol message. Values of 2 through 15 are not defined. Field UM contains the transponder's status (refer to Appendix E) when DI is 1 and SD is XXXXAX (X represents any value, A represents any non-zero value). The status contains the identity of the interrogator and the Comm format for further communications. ID contains the 4096 code selected on the front of the UUT. Field MB contains messages to the interrogator and uses Comm-B format.






1.0µsec
SELF INTERROGATE
SYNC (J10010, PIN 14)
(TO ATC-1400A)
-17.95µsec
DPSK OUT (J10015)
INTERROGATION EXT
PULSE (J10010, PIN 5)
P1
SLS GATE
(J10010, PIN 6)
P2/P5 = ATC, ACS, ACL/SEQ
REPLY INPUT (50% VIDEO)
(J10010, PIN 11)
1.0µsec
SCOPE TRIGGER (J10007)
(SELECTABLE BY ATC-1400A
TO/TAC/TD SWITCH)
T_D
MODE DELAY
-9.95µsec TO +9.95µsec FOR EXTERNAL SYNC
EXT SYNC OUT (J10008)
PULSE POWER
MEASUREMENT GATE
OUT (J10014)
6.0µsec
(EXT SYNC OU
EXT SYNC IN (J10004)
WHEN ENABLED
EXT MOD IN (J10003)
±0.
ANT B (J10002)
P1



DI Test Function Timing Chart
Figure 51

G. BURST Test Function

NOTE: S-1403 controls are identified by alphabetic character identifiers whereas all ATC-1400A controls are identified by numeric character identifers.

NOTE: The following two items highlight BURST Test Function anomalies. Review these items and Appendix F prior to utilizing this test Function.

The BURST number is limited according to the following three formulas:
For a PRF setting of 1 to 399: No limitation
For a PRF setting from 400 to the maximum allowable: Refer to paragraph 1-3-1, table 1.
BURST Number Limit = integer(3.27 ms X PRF) +1

Downlink data is not decoded for this function.

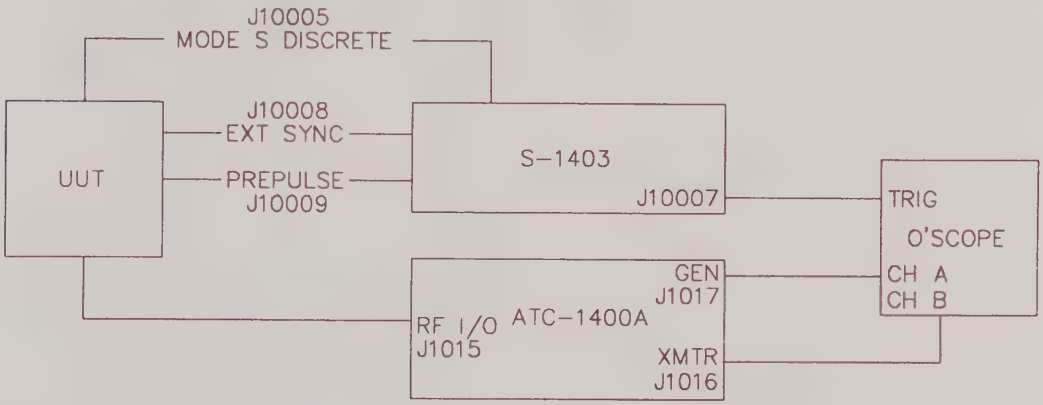
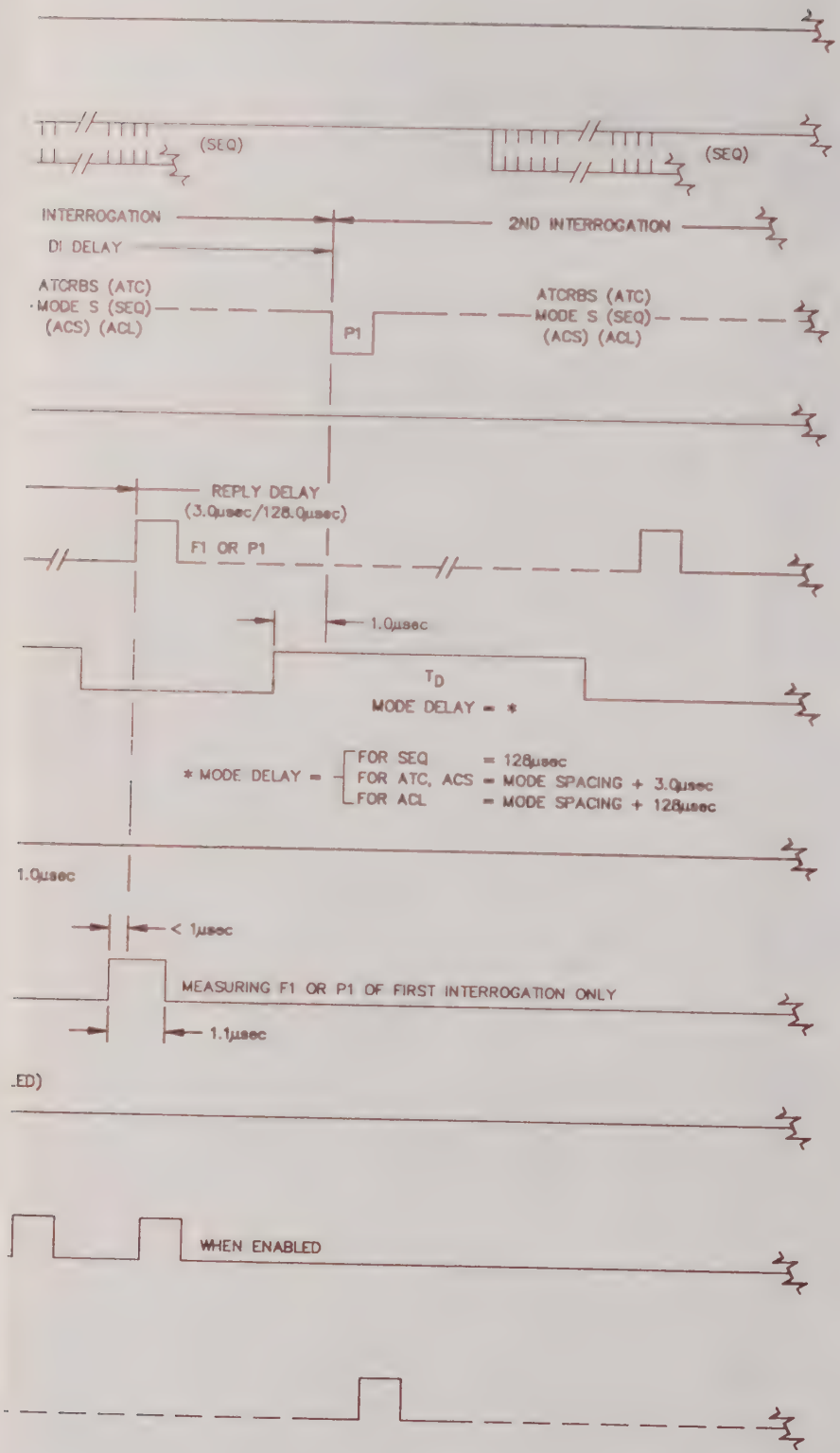


Figure 52 - BURST Test Function Hook-up Diagram

(1) Description of BURST Test Function.

The Burst function allows the user to "Burst" a selected number of SEQ menus or ATC, ACS or ACL formats at the selected PRF rate on the ATC-1400A front panel. For example, the RTCA DO-181 specification requires the Mode S Transponder to reply at the following specified rates for short downlink formats:

50 Mode S replies in any one-second interval;
18 Mode S replies in a 100 µs interval;
8 Mode S replies in a 25 µs interval; and
4 Mode S replies in a 1.6 µs interval.



DI Test Function Timing Chart
Figure 51

G. BURST Test Function

NOTE: S-1403 controls are identified by alphabetic character identifiers whereas all ATC-1400A controls are identified by numeric character identifers.

NOTE: The following two items highlight BURST Test Function anomalies. Review these items and Appendix F prior to utilizing this test Function.

The BURST number is limited according to the following three formulas:
For a PRF setting of 1 to 399: No limitation
For a PRF setting from 400 to the maximum allowable: Refer to paragraph 1-3-1, table 1.
BURST Number Limit = integer(3.27 ms X PRF) +1

Downlink data is not decoded for this function.

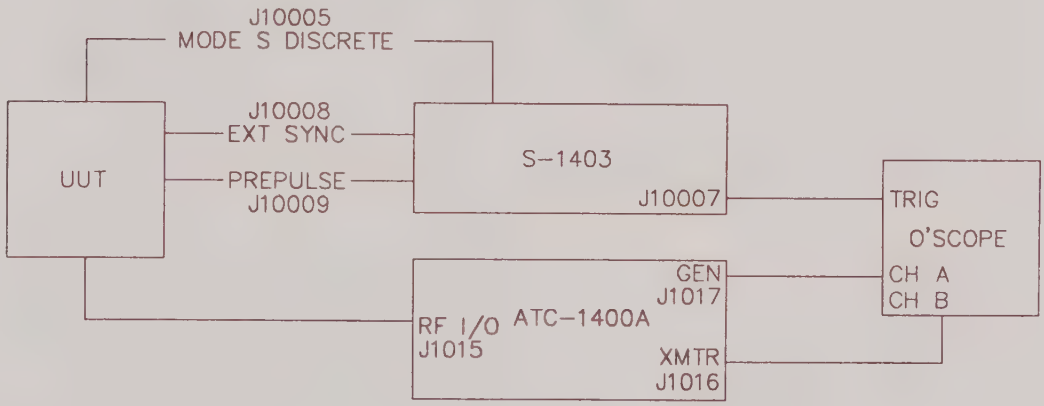


Figure 52 - BURST Test Function Hook-up Diagram

(1) Description of BURST Test Function.

The Burst function allows the user to "Burst" a selected number of SEQ menus or ATC, ACS or ACL formats at the selected PRF rate on the ATC-1400A front panel. For example, the RTCA DO-181 specification requires the Mode S Transponder to reply at the following specified rates for short downlink formats:

50 Mode S replies in any one-second interval;
18 Mode S replies in a 100 µs interval;
8 Mode S replies in a 25 µs interval; and
4 Mode S replies in a 1.6 µs interval.

To accomplish this in the case of the first interval setting, the ATC-1400A PRF/SQTR Thumbwheels (41) are set to 50 (50 per second); the Burst Mode to SEQ, the Burst number to 50, and any uplink format selected for Sequence Item #1. The second interval requires a PRF of 180 and a Burst number of 18, and so on.

Interrogations are sent using both ANT A and ANT B when ANT B is ON. However, replies, reply delay and squitter, are monitored only on ANT B when ANT B is ON and ANT A when ANT B is OFF. Downlink data is not utilized for BURST. Displays are updated after completion of the BURST function operation.

(2) Control Menu #1 Display Definition

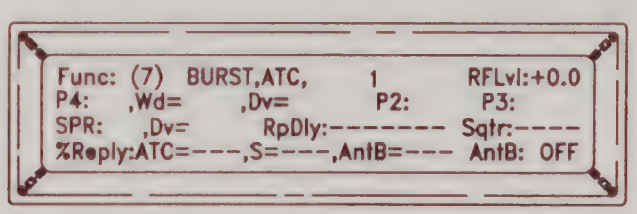


Figure 53 - Burst Control Menu #1

Func:	(7)BURST,___,___ Select ATC, SEQ, ACS or ACL to be Burst at the PRF selected on PRF/SQTR Thumbwheels (41). The number of interrogations (1 to 999) follows the type declaration.
RFLvl:	Adjustments for RF Levels in 0.1 dB steps (within a range of ±3.0 dB). RF adjustments are in addition to the level shown in RF LEVEL -dBm Display (3). Adjustments of 1 dB or greater should be accomplished utilizing SLEW Control (6).
P_4:	Not active in BURST Test Function.
P_4,Wd=:	Not active in BURST Test Function.
P_4,Dv=:	Not active in BURST Test Function.
P_2:	Not active in BURST Test Function.
P_3:	Not active in BURST Test Function.
SPR:	Not active in BURST Test Function.

SPR:,Dv= Not active in BURST Test Function.

RpDly: Displays measured reply delay for ATCRBS (typically 3.0 µs) or Mode S (typically 128 µs) interrogations with 25 ns resolution and 50 ns accuracy.

Sqtr: Displays squitter period (transmission interval of a DF=11 downlink format) from 0.0 to 9.99 sec with 10 ms resolution.

%Reply:ATC=: Displays percent of ATCRBS replies only, from 0 to 127 in 1% steps.

%Reply:S=: Displays percent of Mode S replies only, from 0 to 127 in 1% steps.

%Reply:AntB=: Displays percent of replies from the ANT B connector for ATCRBS and/or Mode S, from 0 to 127 in 1% steps.

AntB: Enables (delay value) or Disables (OFF) Channel B, the diversity generator. When enabled, a value from -0.95 µs to +0.95 µs can be selected as the delay from Channel A to Channel B in 0.05 µs steps.

(3) Control Menu #2 Display Definition

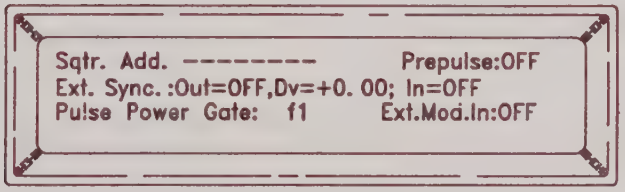


Figure 54 - Burst Control Menu #2

Sqtr.Add. 24-bit octal value decoded from an unsolicited reply (squitter) on Channel A. This value is the Mode S Transponder's address and is transmitted via Downlink Format.

Prepulse:	Prepulse (0 to 260) or OFF control. Prepulse spacing is set from the front panel. The pulse can be positioned from 0 to 260 µs before the rising edge of P_1 of the interrogation, in 1 µs steps.
Ext.Sync.:Out=	ON/OFF control for the external sync output function.
Ext.Sync.:Dv=	Deviation control for external sync output, from -9.95 µs to +9.95 µs in 50 ns steps.
Ext.Sync.:In=	ON/OFF control for external sync input control (positive TTL signal). EXT SYNC OUT is not enabled when SYNC is enabled.
Pulse Power Gate:	Pulse power measurement gate selection from P_1 to P_{116} (by input of a number from 1 to 116 or selected via SLEW Control [F]). The power measurement is performed in the ATC-1400A and displayed on XMTR PWR WATTS Display (1). For all reply pulses, the measurement gate will be enabled prior to the rising edge of the pulse and continue measuring until falling edge. In the case of Mode S replies, since they are in PPM format, care should be taken to ensure the data pulses prior to and following the pulse to be measured are in such a state that their power levels will not be measured as well. For example: to measure P6 power; If P6 is "0", then P5 state doesn't matter and P7 should be a "0". If P6 is a "1", then P5 should be a "1" and P7 state doesn't matter. If P5 were "0" and P6 a "1", no rising edge would be detected and therefore the power reading would be zero. For the S-1403 to control pulse power measurement F_2/P_2-F_1/P_1 Switch (34) must be in the F_2/P_2 position. The F_1/P_1 position will measure the pulse power of an ATCRBS F_1 reply pulse only.

Ext.Mod.In: ON/OFF control for the external input, 0 to +5 volts.

(4) Sequence Menu (Uplink/Downlink Format) Description

BURST Test Function does not utilize sequence menus.

(5) Burst Test Function Timing Diagram

Burst Test function utilizes timing diagrams from the function being tested.

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4. REMOTE (GPIB) OPERATIONS

Remote mode of operation using the IEEE-488 (GPIB) interface in the ATC-1400A will be invoked in the S-1403 whenever the ATC-1400A sends the "REM." mnemonic to the S-1403 over the IFR bus. This occurs whenever an external controller pulls the ATN line on the interface and instructs the ATC-1400A to become a talker or a listener. The S-1403 continues to react in an auxiliary fashion to the ATC-1400A in remote mode similar to the way it does in "local" or front panel mode.

Upon receipt of the remote command, the S-1403 software will disable front panel keyboard and SLEW Control (F) inputs, and respond only to "GPIB" instructions that are transmitted from an external controller over the GPIB. When the remote command is sent to the S-1403, the current display information will be erased and replaced with the message "***REMOTE***". Eliminating the display update allows more efficient operation through the GPIB. This feature may be overridden by issuing one of the display menu commands: "CMENUn." or "SEQN=nn", allowing display updates during REMOTE operations.

CAUTION: ATC-1400A COMMANDS MUST PRECEDE AND BE LOCATED ON A SEPARATE LINE FROM S-1403 COMMANDS. FAILURE TO PLACE COMMANDS ON SEPARATE LINE MAY RETURN FALSE PASS/FAIL INDICATIONS.

NOTE: When menus are displayed during REMOTE operation, there is no displayed indication the system is in REMOTE mode.

NOTE: No keyboard or SLEW Control entries are accepted during REMOTE operation.

The GPIB commands closely resemble, if not duplicate, the expression used in the control and sequence menus. All commands and data are printable ASCII characters.

All commands sent to the S-1403 are identified by the use of special delimiters which classify the command as either a "set", "get", or "enable" instruction as follows:

"=" represents a "set value to" operation

"?" represents a "get value" operation

"." represents an "enable" operation

Command lines sent to the S-1403 Test Auxiliary must be preceded with the prefix "AX3=", as in :

AX3=(command 1) : (command 2) :...(command n)

NOTE: The command AX3= replaces the first five digits (UF field and DF field) of Downlink and Uplink transmission formats.

Any error conditions identified in local mode are also active in remote mode, however the errors are combined into one of three error messages that is sent to the ATC-1400A which will then set bit 1 of the SRQ register. There are generally four types of errors: RCVDATA error is the GPIB error received when the AP addresses are not the same; Input error occurs when an invalid GPIB command has been entered; and Mode error occurs when the unit is in DME mode and any command except RFLvl is entered. RECALL error occurs when a recall command has been issued and no data was previously saved.

In the following command table, each command is shown separately as it would be executed through the ATC-1400A. In the command field, the "-" signifies a data or election entry field. The fields are separated by semicolon(s) ";". The fields will all be initialized to either the power on or the latest front panel values before going remote. The fields need not be updated each time the command is executed if no change is desired. Each field preceding the field to be changed can be skipped by sending only the semicolon separator: e.g. "P_4=;;+1.0" updates the P_4 pulse deviation only without changing the preceding level or width control fields.

In the range column, "***" indicates no value to be input or returned, otherwise a range of input values is given. If mnemonics are to be selected, the possible ones are separated by a backslash. Values to be returned are indicated by placing the values in parentheses. For example, the P_4 level control may be set to the calibrated position, the variable level position, or turned off by selecting either CAL or (/) VAR or (/) OFF.

A more detailed definition of each function is given in the front panel control section. The user should be familiar with this section before attempting to utilize the S-1403 in remote mode.

COMMAND	RANGE/VALUES	DEFINITION
AX3=ATC	***	Enables ATCRBS interrogations only.
AX3=SEQ.	***	Enables Mode S interrogations only.
AX3=ACS.	***	Enables All-Call interrogations with a short P4 pulse and set pulse spacing at 8 µs (A) or 21 µs (C).
AX3=ACL.	***	Enables All-Call interrogations with a short P4 pulse and set pulse spacing at 8 µs (A) or 21 µs (C).
AX3=INTLCE=_	1 to 999	Enables interlace mode and set the ratio of Mode S interrogtions to ATCRBS interrogations.
AX3=DI=_;_	ATC/ACS/ACL/SEQ; ATC/ACS/ACL/SEQ	Enables double interrogation mode and set type of interrogation desired for the first and second interrogations.
AX3=BURST=_;_	ATC/ACS/ACL/SEQ; 1 to 199	Enables Burst mode. Set the type of interrogation to be burst and the number of times to generate it.
AX3=BURST.	***	Activates the BURST function, if selected.
AX3=MODE?	ATC/SEQ/ACS;_/ACL:/INTLCE;___/DI:_,__/BURST;____,___	Displays mode Status. The mode is preceded by the selected option(s).
AX3=RFLV=__	-3.0 to +3.0 in 0.1 dB steps.	Sets RF level.
AX3=RFLV?	-3.0 to +3.0 dB	Displays RF vernier level.

Mode S GPIB Instruction Set
Table 4

COMMAND	RANGE/VALUES	DEFINITION
AX3=P4=_;_;_	CAL/VAR/OFF; CAL/0.20 to 3.20; CAL/-1.95 to +1.95	Sets P4 (ACS/ACL) pulse conditions. The first field sets the pulse level, second field sets the pulse width and third field sets the deviation in 0.05 µs steps.
AX3=P4?	CAL/VAR/OFF; CAL/0.20 to 3.20; CAL/-1.95 to +1.95	Displays status of P4 pulse.
AX3=P6=_;_;_	CAL/OFF; CAL/-1.50 to +1.50; CAL/-1.95 to +1.95	Sets P6 (Mode S) pulse CAL/-1.95 to +1.95 conditions. The first field sets the pulse level, second field sets the pulse width, third field sets the deviation in 0.05 µs steps.
AX3=P6?	CAL/OFF; CAL/-1.50 to +1.50; CAL/-1.95 to +1.95	Returns status of P6 pulse.
AX3=P2=_	CAL/VAR/OFF	Sets level control to P2 pulse, either calibrated to 0 dB or variable control through SLS/ECHO ON/OFF Switch (18), when ON.
AX3=P2?	CAL/VAR/OFF	Displays status of P2 level control.
AX3=P3=_	CAL/VAR/OFF	Sets level control for P3.
AX3=P3?	CAL/VAR/OFF	Displays status of P3 level control.
AX3=SPR=_;_	ON/OFF; CAL/-1.00 to +1.00	Sets level control and deviation control for the Sync Phase Reversal.
AX3=SPR?	ON/OFF; CAL/-1.00 to +1.00	Displays status of SPR control.

Mode S GPIB Instruction Set
Table 4 (Cont'd)

COMMAND	RANGE/VALUES	DEFINITION
AX3=RPDLY?	000.000 to 399.000	Displays UUT reply delay in microseconds.
AX3=SQTR?	0.00 to 9.99	Displays UUT squitter period in seconds.
AX3=PRPLY?	0 to 127; 0 to 127; 0 to 127	Displays percent reply from UUT as percent of ATC, Mode S and Antenna B connector.
AX3=ANTB=_	OFF/-0.95 to +0.95	Sets control for the diversity channel (ANT B). Off disables ANT B to allow programmed delay from Channel A in 0.05 µs steps.
AX3=ANTB?	OFF/-0.95 to +0.95	Displays status of diversity control.
AX3=SQADD?	00000000	Displays the address of the squitter reply as an eight-digit octal value.
AX3=PPULSE=	0 to 260/OFF	Sets prepulse offset from 0 to 260 µs prior to P1 rising edge or OFF (disabled)
AX3=PPULSE?	0 to 260/OFF	Displays status of prepulse control.
AX3=EXSYN=_ ;_;_	ON/OFF;-9.95 to +9.95 ON/OFF	Enables or disables external synchronous output. Controls deviation of external synchronous pulse and enables or disables external synchronous input pulse.
AX3=EXSYN?	ON/OFF; -9.95 to +9.95 ON/OFF	Displays status of external synchronous control.
AX3=PPMG=_	OFF/1 to 16 ATC or OFF/1 to 116 (SEQ)	Sets Pulse Power Measurement Gate control for any pulse in the UUT reply for ATC mode (1 to 16), or SEQ mode (1 to 60) for short formats, or 1 to 116 for long formats.

Mode S GPIB Instruction Set
Table 4 (Cont'd)

COMMAND	RANGE/VALUES	DEFINITION
AX3=PPMG?	1 to 16 in ATC or 1 to 116 in SEQ	Displays the PPMG control status.
AX3=EXMOD=_	ON/OFF	Enables or disables external modulation inputs.
AX3=EXMOD?	ON/OFF	Displays status of external modulation input control.
AX3=SQnn=_;_ :_:_	nn=01 to 16; F/S/L; 00 to 31; 0 to 777777777 (short) or 0 to 37777777777777777 777777777(long) 0 to 7777777	Programs Sequence Item Number , 01 to 16, to be OFF/Short/Long; function number in decimal # bit data field (short) or 83-bit data field (long); and a 24-bit address field.
AX3=SQnn?	nn=01 to 16; F/S?L 00 to 31; 777777777 (short) or 37777777777777777 77777777777 (long); 0 to 77777777	Displays status of sequence number (01 to 16).
NOTE: Octal fields are justified right, referenced to the next field separator or end of line control character.		
AX3=DFSQnn?	nn=01 to 16; F/S/L 00 to 31; 0 to 777777777 (short) or 0 to 37777777777777777 77777777777 (long); 0 to 777777777	If no downlink format data exists, s "NO DATA" will be displayed. Displays downlink format data for sequence item number (01 to 16).
AX3=SAVEn	n= 1 or 2	Enables the S-1403 to store the current test setup in non-volatile memory storage area (1 or 2).
AX3=RECALLn	n= 1 or 2	Enables the S-1403 to recall the test setup stored in non-volatile memory area (n) and make it the active storage area.

Mode S GPIB Instruction Set
Table 4 (Cont'd)

COMMAND	RANGE/VALUES	DEFINITION
AX3=RECALLn	n= 1 or 2	Enables the S-1403 to recall the test setup stored in non-volatile memory area (n) and make it the active storage area.
AX3=SEQN=__	1 to 16 (decimal)	Enables the S-1403 to display the Sequence Menu beginning with the item number (1 to 16) entered from the front panel.
AX3=CMENUn.	n= 1 or 2	Enables the S-1403 to display Control Menu 1 (n=1) or 2 (n=2) on the front panel.
AX3=ERRM?	(INPUT/RCVDATA) RECALL/MODE/RATE , DI/INTFF	Displays error status as a command error, data input error, incorrect or inactive mode error, or no error. This is usually requested after the GPIB controller receives serial poll data indicating an auxiliary error when Bit 1 (SRQ) bit is set.

Mode S GPIB Instruction Set
Table 4 (Cont'd)

When utilizing the GPIB commands, the Uplink and Downlink signal formats defined in RTCA Document 181 are not available within the Mode S system as defined formats. To transmit one of these specified formats requires the user to manually formulate the signals as shown in Tables 1 and 2, Appendix E.

EXAMPLE 1: Send Uplink Format 05 (Short Format).

From Appendix B:
UF=05, Sequence number=03
PC, RR, DI, SD and AP data fields are used
Example transponder address is 17725762

Refer to Appendix E for description of possible commands along with associated sub-commands.

Description of command (From Table 3, Appendix E):

COMMAND	EXPLANATION
PC	Data being sent is for information only.
RR	Flight ID being interrogated.
DI	SD field contains multisite information.
SD	Field is comprised of sub-fields IIS, MBS, LOS, RSS and TMS.
IIS	Identification of interrogator.
MBS	Reserve COMM-B for use.
MES	Close out COMM-C and COMM-D from use.
LOS	Lockout field listed in IIS from further All-Call interrogations, continue to acknowledge any other All-Call requests.
RSS	No request for field UM (Not used).
TMS	Unlinked Message/Request, acknowledge receipt.

Explanation of the data contained in the first 9 octal digits.

```
100   01111   001   0110   01    111   1   00   0010
PC     RR      DI    IIS   MBS   MES LOS RSS   TMS
                \_____________SD_____________/
```

To convert the binary pulse representation to nine digit (octal), make a table similar to the following:

BINARY	100	011	110	010	110	011	111	000	010
OCTAL	4	3	6	2	6	3	7	0	2

Command	Definition
AX3=	Command to notify S-1403 to transfer command of tests to be conducted from the Front Panel to GPIB.
SQ03	Sequence Menu #03 (See Appendix B).
S	Short data field length.
05	Uplink format 05 (Decimal).
436263702	Nine-digit (Octal) data field.
17725762	Eight-digit (Octal) transponder address.

GPIB Command is AX3=SQ03;S;05;436263702;17725762

EXAMPLE 2: Send Uplink Format 21 (Long Format).

From Appendix B
UF21 is long format.
PC, RR, DI, SD, MA and AP fields are active.
Example transponder address is 17725762.

Refer to Appendix E for description of possible commands along with associated sub-commands.

Command	Explanation
PC	Non-selective All-Call lockout.
RR	Identification of aircraft being interrogated.
DI	Notice to expect extended information.
SD	Field is comprised of sub-fields IIS, RRS, LOS and TMS.
IIS	Interrogator Identification.
RRS	Transmit reply in extended format.
LOS	Lockout all All-Call responses.
TMS	Linked first segment, multiple addresses, Priority individual call, acknowledge.
MA	Field is comprised of sub-fields ADS and message.
ADS	Extended message immediately follows.
*	Data bits not used in this Uplink Format message.

Explanation of the data contained in the first 35 binary digits:

```
001  10010  111  0100  0101  0  1  00  1011  01011100  0...0
PC     RR    DI   IIS   RRS   * LOS  *   TMS   ADS    Message
                \___________SD_______________/\_____MA______/

      BINARY  001 100 101 110 100 010 101 001 011 010 111 00
      OCTAL     1   4   5   6   4   2   5   1   3   2   7   0
```

COMMAND EXPLANATION

AX3=	Command to notify S-1403 to transfer command of tests from Front Panel control to GPIB.
SQ07	Sequence Menu 07 (See Appendix B)
L	Long data field length
21	Uplink format 21 (Decimal).
1456...00	25 digit (Octal) data field.
17725762	8 digit (Octal) transponder address.

GPIB Command:
AX3=SQ07;L;21;1456425132700000000000000;17725762

Example 3: Receive Downlink Format 04 (Altitude reply)

From Appendix B
DF04 is short format
FS, DR, UM, AC and AP data fields are used.
Example transponder address is 17725761

GPIB Return 3;S;4;17677;17725761

Response	Definition
3	Notification to S-1403 to accept GPIB data
S	Short Format
4	Downlink Format 4
17677	Octal data field.
17725761	Example transponder address

To convert the 5 (octal) digits to altitude (decimal), proceed as follows:

1. Convert the octal data field digits to binary using the following format:

	c1	a1	c2	a2	c4	a4	X	b1	d1	b2	d2	b4	d4
B10	B9	B8	B7	B6	B5	X	B4	Q	B3	B2	B1	B0	
1	1	1	1	1	1	0	1	1	1	1	1	1	

If bit position Q (d1) is 0, the altitude readout is ATCRBS, refer to Appendix D, ATC-1400A Operation/Maintenance Manual for the solution.

2. Discard bit positions X and Q, and separate the bits into three fields as follows:

B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0
1	1	1	1	1	1	1	1	1	1	1

3. Convert these binary characters into hexidecimal characters.

B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0
1	1	1	1	1	1	1	1	1	1	1
7			F				F			

4. Convert the 3-digit (hexidecimal) altitude code to decimal code.

4E1 = 2047

5. Multiply decimal number by 25.

2047 X 25 = 51175

6. Subtract 1000 from the answer derived in step 5.

51175 - 1000 = 50715

This is your altitude and should agree with the answer shown in sequence menu S02, AC= field.

Example 4: Receive Downlink Format 05 (Identification Reply)

From Appendix B
DF05 is short format
FS, DR, UM, ID and AP data fields are used
Example transponder address is 17725761

GPIB return is 3;S;5;17404;17725762

Response	Definition
3	Notification to S-1403 to accept GPIB data
S	Short Format
5	Downlink Format 5
17401	ID data field
17725761	Example transponder address

To convert the five-digit (octal) to the correct four digit (octal), proceed as follows:

1. Convert the five-digit (octal) reply to binary using the following format:

c1	a1	c2	a2	c4	a4	X	b1	d1	b2	d2	b4	d4
1	1	1	1	1	0	0	0	0	0	1	0	0

2. Rearrange the binary bits to the following format, discarding bit position X.

a4	a2	a1	b4	b2	b1	c4	c2	c1	d4	d2	d1
0	1	1	0	0	0	1	1	1	0	1	0

3. Convert the binary bits to octal:

a4	a2	a1	b4	b2	b1	c4	c2	c1	d4	d2	d1
0	1	1	0	0	0	1	1	1	0	1	0
	3			0			7			2	

This is your identification code and should agree with the answer shown in sequence menu 03, ID= field.

Binary	Octal
001	1
010	2
011	3
100	4
101	5
110	6
111	7

Table 5 - Binary to Octal conversion table

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5. S-1403 PERFORMANCE VERIFICATION

A. General

The procedures in this section test the electrical performance of the S-1403 using the specifications of Section 1-3-1 as the performance standards. The performance tests must be performed in the sequence given, since some of the procedures rely on satisfactory results in previous tests.

The performance tests conducted in this section are designed to give the user a high level of confidence that the Mode S Test System meets specifications as listed in Section 1-3-1, Specifications, but do not guarantee that all specifications are met, since not all specifications are evaluated. The performance verification tests require about 3 hours to perform.

B. Pre-Operational Conditions

For maximum benefit of all operating procedures, it is strongly recommended that all personnel:

(1) Read and thoroughly understand all steps of the procedure to be performed, prior to its completion.

(2) Be familiar with the circuit or unit under test so some idea is perceived as to the power, frequency, and waveform to be expected at each test point. This knowledge will aid personnel in performing the test procedure logically and efficiently.

C. Test Equipment Requirements

Equipment required for the performance tests are listed in the beginning of the performance test to be conducted. Appendix C - Test Equipment Requirements contains a comprehensive list of test equipment suitable for performing any of the procedures in this manual. Any other test equipment meeting the specifications listed in Appendix C may be substituted for the recommended models. For certain procedures, test equipment listed in Appendix C may exceed the minimum required specifications.

D. Corrective Maintenance Program

These performance checks provide a method for validating specific hardware, software and signal parameters. Should the performance checks confirm invalid parameter(s), the S-1403 must be recalibrated per Section 2-2-2 Calibration or returned to an Authorized Repair Station as appropriate.

E. Initial ATC-1400A Control Settings

Before any performance evaluation, the ATC-1400A controls shall be set as follows:

	CONTROL	SETTING
7	CW/NORM/OFF Switch	NORM
18	SLS/ECHO ON/OFF Switch	OFF
25	XPDR DEV P3/CAL Switch	CAL
28	XPDR DEV P2/CAL Switch	CAL
32	PRF/SQTR ON/OFF Switch	ON
37	TACAN ON/OFF Switch	OFF
38	XPDR MODE Control	A
40	DISPLAY SELECT Control	PRF SQTR Hz
41	PRF/SQUITTER Thumbwheels	0200
42	DBL INTERR/INTERF Thumbwheels	000.0 OFF
45	FREQ/FUNCTION SELECT Thumbwheels	1030 XPDR
48	ΔF Thumbwheels	OFF
52	RANGE/VEL/ACCEL Thumbwheels	00000
66	SELF INTERROGATE ON/OFF Switch	OFF

NOTE: Remaining ATC-1400A controls do not require initial setting.

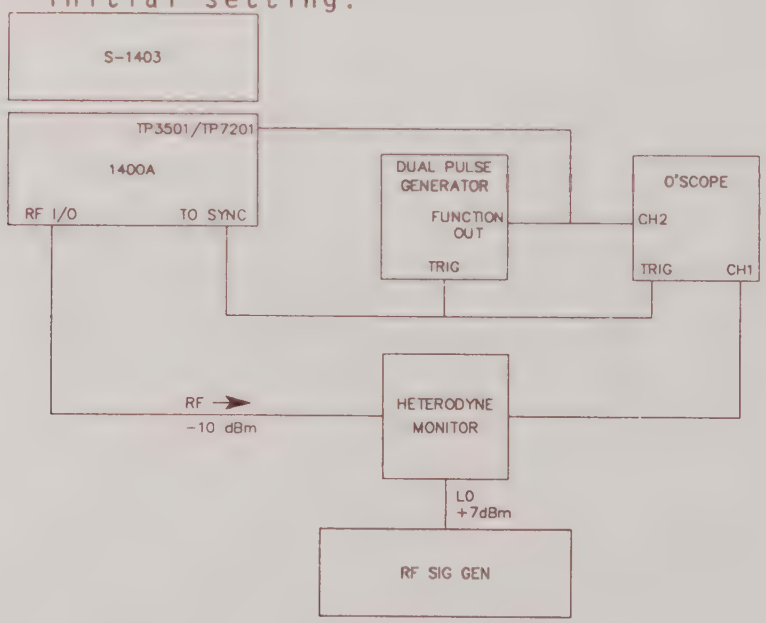

Figure 55 UUT Reply Measurement

F. Procedure

Equipment Required:

S-1403
ATC-1400A
Dual Pulse Generator
Dual Trace Oscilloscope
Heterodyne Monitor
RF Signal Generator

Prerequisite: System calibrated per Chapter 2-2-2.

NOTE: Alphabetic character identifiers refer to the S-1403 whereas numeric character identifiers refer to the ATC-1400A.

Step Procedure

Initial Conditions and Settings

1. Connect GEN OUT Connector (15) to Oscilloscope Channel 1 input.
2. Connect Oscilloscope External Trigger to S-1403, J10007 Connector (AA).
3. Apply electrical power to S-1403 and ATC-1400A.

S-1403 to ATC-1400A Communication

4. Verify "Initializing" is displayed on Menu Display (I) for less than 30 seconds.
5. Verify MENU Display (I) is FUNC: (1) ATC, after Initialization period has ended.
6. Set FREQ/FUNCTION SELECT Thumbwheel (45) to TAC Y.
7. Verify "*DME MODE*" is displayed on top line of MENU Display (I).
8. Set FREQ/FUNCTION Select Thumbwheel (45) to XPDR.
9. Verify MENU Display (I) is FUNC: (1) ATC.

ATC Function (1)

10. Set T_O/TAC/T_D Switch (30) to T_O.
11. Verify P_1 to P_3 pulse spacing is 8.0 µs (±10 ns).
12. Position XPDR MODE Control (38) to C.
13. Verify P_1 to P_3 spacing is 21 µs (±10 ns).

Step	Procedure

SEQ Function (2)

14. Select S-1403 Keyboard ON/CAL key.

15. Verify MENU Display (I) is FUNC:(2) SEQ.

16. Verify Display coincides with Figure 12, Section 1-2-3.

17. Depress SMENU Key.

18. Verify S01 (Sequence Menu number 1) is displayed.

19. Use SLEW Control (F) to change sequence menu to S02.

20. Depress ON/CAL Key to set S02 to OFF.

21. Repeat Steps 21 and 22 for S03 thru S08.

22. Use SLEW Control to verify S02 thru S08 are OFF.

23. Verify S01 is ON.

24. Verify Mode S interrogation pulse pattern of P_1, P_2 and P_6, per Figure 21, Section 1-2-3.

ACS Function (3)

25. Depress 2nd, FUN NO, 3 Keys.

26. Verify Display coincides with Figure 23, Section 1-2-3.

27. Verify ATCRBS Mode A (All Call Only) interrogation per Table B, Figure 25, Section 1-2-3.

ACL Function (4)

28. Depress Keyboard ON/CAL Key.

29. Verify Display coincides with Figure 27, Section 1-2-3.

30. Set Mode to C.

31. Verify ATCRBS Mode C/Mode S ALL-CALL interrogation per Table B, Figure 29, Section 1-2-3.

INTLCE Function (5)

32. Depress Keyboard 2nd, FUN NO, 5 Keys.

33. Verify Display coincides with Figure 31, Section 1-2-3.

34. Verify ATCRBS Function consists of P_1 and P_3.

35. Verify Mode S pulse pattern consists of P_1, P_2 and P_6 occuring 200 µs following P_1 of the ATCRBS interrogation.

Step	Procedure

DI Function (6)

36. Depress Keyboard ON/CAL Key.

37. Position DBL INTERR/INTERF PULSE Thumbwheels (42) to 200.0 and DOUBLE.

38. Set PRF/SQTR Thumbwheel (41) to 100.

39. Verify Display coincides with Figure 42, Section 1-2-3.

40. Verify ATCRBS function consists of P_1 and P_3 21 µs apart.

41. Verify second ATCRBS interrogation occurs 200 µs after P_1 of the first interrogation.

42. Verify first interrogation appears 1.0 µs following Trigger.

43. Set T_0/TAC/T_D Switch (30) to T_D.

44. Verify 2nd interrogation appears 1 µs following Trigger.

45. Move cursor to 2nd interrogation format field. Using ON/CAL Key or SLEW Control (F) select each format and verify the output at the GEN Connector (15) changes accordingly.

46. Set T_0/TAC/T_D Switch (30) to T_0.

47. Verify ACS, ACL and SEQ for first interrogation.

BURST Function

48. Depress 2nd, FUN NO, 7 Keys.

49. Position DBL INTERR/INTERF PULSE Thumbwheels (42) to 200, OFF.

50. Verify display coincides with Figure 53, Section 1-2-3.

51. Position cursor to the BURST# field.

52. Enter 100.

53. Depress Keyboard ENT Key.

54. Set PRF/SQTR Thumbwheels (41) to 50.

55. Depress Burst Key.

56. Verify ATCRBS P_1 to P_3 spacing of 21 µs. Interrogation should continue for two seconds (PRF=50).

Step	Procedure

P_4 (P_6) Control

All Call Functions (P_4)

57. Connect RF I/O Connector (9) to Oscilloscope Channel A using Heterodyne Monitor. Set ATC-1400A output level to -10 dBm.

58. Depress Keyboard 2ND, FUN NO, 4 Keys. ACL Control Menu #1 should be displayed.

59. Position cursor to "P_4, Wd=" field.

60. Depress ON/CAL Key. This will enable variable width control.

61. Verify variable width setting (P_4, Wd=) is 0.0.

62. Verify P_4 pulse width on oscilloscope Channel 1 is 1.6 µs (±50 ns).

63. Enter variable width value of +1.95 µs.

64. Verify pulse width of 3.55 µs.

65. Depress keyboard 2ND, FUN NO 3, Keys. ACS Control Menu #1 should be displayed.

66. Position cursor to "P_4, Wd=" field.

67. Verify 2.75 µs (±50 ns) width.

68. Depress ON/CAL Key. "P_4, Wd=" field should now display CAL.

69. Verify width is 0.8 µs.

70. Depress ON/CAL Key.

71. Verify P4 Pulse width can be incremented/decremented in 50 ns steps from 0.2 µs to 2.75 µs from CAL position when utilizing SLEW Control (F).

72. Verify changing P_4 width has no effect on pulse width of P_1, P_2 or P_3.

73. Depress 2ND, FUN NO, 4 Keys. ACL Control Menu #1 should be displayed.

74. Position cursor to "P_4, Wd" field.

75. Verify P_4 width is variable from 0.2 µs to 3.55 µs pulse width (50 ns).

76. Using SLEW Control (F), return "P_4, Wd" to 0.00. Press ON/CAL Key to return P_4 to CAL.

Step	Procedure
77.	Position cursor to "P_4, Dv=" field. Value displayed should be CAL. If not, depress ON/CAL Key until CAL is displayed.
78.	Verify P_1 to P_4 spacing is 10.0 µs (±10 ns).
79.	Set XPDR MODE Switch (38) to Mode C.
80.	Verify P_1 to P_4 spacing is 23.0 µs (±10 ns).
81.	Position cursor to "P_4, Dv=" field.
82.	Depress ON/CAL Key until "P_4, Dv=" field displays numerical value.
83.	Using SLEW Control (F) verify deviation can be varied ±1.95 µs (±10 ns) in 50 ns steps.
84.	Depress ON/CAL Key until "P_4, Dv=" field displays CAL.
85.	Position cursor to "P_4:" field.
86.	Depress ON/CAL until "VAR" is displayed.
87.	Set SLS/ECHO Thumbwheels (50) to 0.
88.	Verify P_4 level equals P_3 level (±0.3 dB).
89.	Vary SLS/ECHO Thumbwheel from -10 dB to +3 dB.
90.	Verify level at each change (±0.3 dB).
91.	Set SLS/ECHO Thumbwheels (50) to 0. Set P_4 to CAL by depressing ON/CAL Key twice.
92.	Using Heterodyne Monitor, verify P_4 rise time from the 10 to 90% points is 70 ns (±20 ns); also verify fall time from 90 to 10% points is 70 ns (±20 ns).
	Mode S (P6) Control
93.	Depress 2ND, FUN NO, 2 Keys. Verify "FUNC:(2) SEQ" is displayed on Control Display (I).
94.	Depress SMENU Key.
95.	Use CURSOR Keys (A) to move cursor to UF#__ field.
96.	Use SLEW Control (F) to set UF# to 16.
97.	Verify P_6 width is 30.25 µs (±50 ns).
98.	Use SLEW Control (F) to set UF# to 00.
99.	Verify P_6 width is 16.25 µs (±50 ns).
100.	Depress CMENU, 1 Keys.

Step	Procedure
101.	Use CURSOR Keys (A) to move cursor to "P_6, Wd=" field.
102.	Depress ON/CAL Key. Numerical value should be displayed.
103.	Utilizing SLEW Control (F), verify P_6 width varies from -1.5 to +1.5 µs (±50 ns) in 50 ns steps from CAL position.
104.	Depress ON/CAL Key. "CAL" should be displayed.
105.	Use CURSOR Keys (A) to move cursor to "P_6, Dv=" field.
106.	Verify "CAL" is displayed.
107.	Verify P_6 position is 3.5 µs (±10 ns) following P_1.
108.	Depress ON/CAL Key. Numerical value should be displayed.
109.	Utilizing SLEW Control (F), verify P_6 position can be incremented/decremented from -1.95 to +1.95 µs (±50 ns), in 50 ns steps from CAL position.
110.	Depress ON/CAL until CAL is displayed.
	SYNC Phase Reversal (SPR) Control
111.	Use CURSOR Keys (A) to move cursor to "SPR,Dv=" field.
112.	Verify SPR occurs 2.75 µs (±50 ns) following rising edge of P_2 (CAL).
113.	Depress ON/CAL Key until a numerical value is displayed.
	SLS Control
114.	Utilizing SLEW Control (F), verify SPR varies from 1.75 to 3.75 µs from P_2 (±50 ns), in 50 ns steps.
115.	Depress ON/CAL Key until "CAL" is displayed.
116.	Depress 2ND, FUN NO, 4 Keys. Verify "FUNC:(4) ACL" Menu is displayed.
117.	Set SLS/ECHO ON/OFF Switch (18) to ON.
118.	Set SLS/ECHO Thumbwheel (50) to 0 dB.
119.	Verify SLS pulse occurs 2.0 µs following P_1.
120.	Verify SLS pulse width is 800 ns (±100 ns).
121.	Verify P_2 amplitude equals P_1 amplitude (±0.3 dB).
122.	Set SLS/ECHO Thumbwheel (50) to -10 dB.

Step	Procedure

123. Verify output level is -10 dB (±0.3 dB).

124. Increment SLS/ECHO Thumbwheel and verify output level is ±0.3 dB of level displayed at SLS/ECHO Thumbwheel.

125. Set SLS/ECHO Switch (18) to OFF.

Reply Delay

126. Prepare test setup per Figure 55, UUT Reply Measurement.

127. Set Dual Pulse Generator to produce two 0.45 µs wide pulses spaced 20.3 µs apart. Set output level for negative going pulses as per Figure 56.

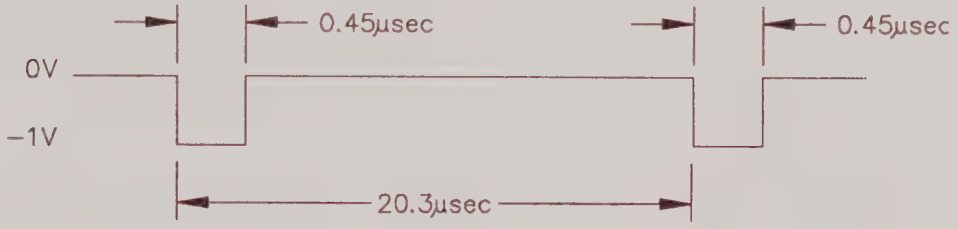

Figure 56 Pulse Generator Waveform

128. Depress 2ND, FUN NO, 1 Keys.

129. Adjust Generator for 3.0 µs delay from interrogation P_3 to Generator first pulse.

130. Verify Menu Display field "RpDly:" displays value measured on Oscilloscope (±100 ns).

131. Select 2ND, FUN NO, 2 Keys. Verify "FUNC:(2) SEQ" Menu is displayed.

132. Adjust Generator for 128 µs delay from interrogation SPR to Generator first pulse.

133. Verify Menu Display field "RpDly:" displays value measured on Oscilloscope (±50 ns).

Percent Reply Measurements

134. Select 2ND, FUN NO, 1 Keyboard Keys. Verify "FUNC:(1) ATC" Menu is displayed.

135. Set Pulse Generator to 3.0 µs Reply Delay.

136. Set PRF/SQTR Thumbwheels (41) to 500.

Step	Procedure

137. Verify "% REPLY: ATC" field display 100% (±1 count).

138. Verify "% REPLY: S" field display is zero (0).

139. Select Pulse Generator Trigger-Internal.

140. Set Pulse Generator PRF to 500.

141. Verify Pulse Generator PRF with Frequency Counter (±1%)

142. Verify "% REPLY: ATC" field displays 100% (±1 counts).

143. Set Pulse Generator PRF to 635.

144. Verify Pulse Generator PRF with Frequency Counter (±1%)

145. Verify "% REPLY: ATC" field displays 127% (±1 counts).

146. Disconnect Pulse Generator.

PREPULSE Test

147. Depress 2ND, FUN NO, 2 Keyboard Keys. Verify "FUNC:(2) SEQ" Menu is displayed.

148. Set PRF/SQTR Thumbwheels to 200.

149. Depress CMENU, 2 Keys. Verify Control Menu 2 is displayed.

150. Use CURSOR Keys (A) to move cursor to "PREPULSE" field.

151. Depress ON/CAL Key.

152. Enter 00.

153. Depress ENT Key.

154. Connect Oscilloscope Channel A to PREPULSE OUT, J10009, Connector (EE).

155. Connect GEN Connector (15) to Oscilloscope Channel B.

156. Verify interrogation P_1 leading edge is coincident with trigger (±100 ns).

157. Increase Prepulse Delay to 260 µs utilizing SLEW Control (F).

158. Verify P_1 position is coincident with "PREPULSE" field value as SLEW Control is rotated (±100 ns).

EXT SYNC OUT Test

159. Set Prepulse field to 12 utilizing SLEW Control (F).

160. Connect Prepulse to scope trigger IN.

Step	Procedure
161.	Connect EXT SYNC OUT Connector (J10008) to Oscilloscope Channel A.
162.	Use CURSOR Keys to select EXT.SYNC.:OUT field.
163.	Select ON/CAL Key until ON is displayed.
164.	Use CURSOR Keys to select "EXT.SYNC.:OUT Dv=" field. Verify "0.00" is displayed.
165.	Set Oscilloscope for external trigger with both Channels A and B displayed. Verify EXT.SYNC. pulse is coincident with interrogation P_1 pulse (±100 ns).
166.	Set Ext.Sync.Out,Dv= field to +9.95.
167.	Verify Ext.Sync.Out pulse follows interrogation pulse by 9.95 µs (±100 ns).
168.	Press +/- Key to change Ext.Sync.Out,Dv= value to -9.95.
169.	Verify Ext.Sync.Out pulse precedes interrogation pulse P1 by 9.95 µs (±100 ns).
170.	Set "EXT.SYNC.:OUT Dv=" field to 0.0 utilizing SLEW Control (F).

EXT SYNC IN Test

171.	Use CURSOR Keys to move cursor to "EXT.SYNC.:IN=" field.
172.	Depress ON/CAL Key until "EXT.SYNC.:IN=" field displays ON.
173.	Set Dual Pulse Generator to Single Pulse Output and internal sync.
174.	Connect Pulse Generator TTL output to EXT SYNC IN (J10004) Connector (BB).
175.	Connect Pulse Generator Sync Out to Oscilloscope Ext Trig.
176.	Connect GEN Connector (15) to Oscilloscope Channel A.
177.	Verify Mode S interrogations are coincident with Oscilloscope trigger.
178.	Vary Pulse Generator PRF Control.
179.	Verify interrogation rate tracks pulse generator PRF. With ON/CAL Key set "EXT.SYNC.:IN=" to OFF.

Step Procedure

EXT MOD IN

180. Connect PREPULSE OUT (J10009) Connector (EE) to Dual Pulse Generator trigger input and Oscilloscope trigger.

181. Select external trigger mode on Pulse Generator. Set for double pulse output.

182. Disconnect Dual Pulse Generator TTL output from EXT SYNC IN (J10004) Connector (BB).

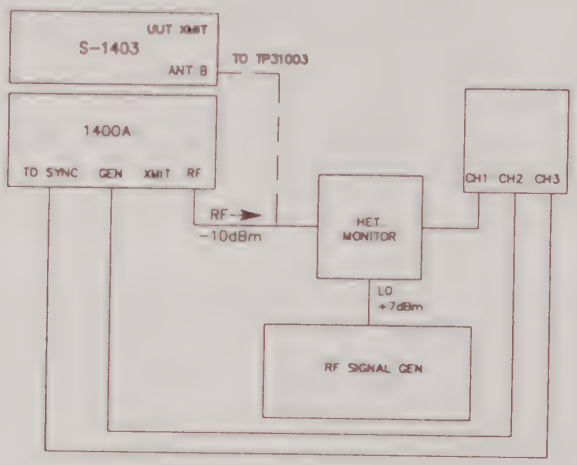

Figure 57 Antenna B Time Delay

183. Connect Dual Pulse Generator TTL Output to EXT MOD IN (J10003) Connector (Z).

184. Move cursor to EXT.MOD.IN: using ON/CAL Key select ON.

185. Verify the pulses present at GEN Connector (15) coincide with pulse generator output.

186. Use ON/CAL Key to set Ext.Mod.In OFF.

PULSE POWER MEASUREMENT Test

187. Set Dual Pulse Generator to produce two 0.45 µs pulses spaced 20.3 µs apart. Set output level per Figure 56.

188. Use CURSOR Keys (A) to move cursor to "EXT.SYNC.:OUT" field.

189. Depress ON/CAL Key until ON is displayed.

190. Connect EXT SYNC OUT (J10008) Connector (CC) to Dual Pulse Generator trigger input.

191. Connect Dual Pulse Generator function out to TP3501 ATC-1400A or TP7201 (modified 1400).

Step	Procedure

192. Set F_2/P_2 F_1/P_1 Switch (34) to F_1/P_1.

193. Select 2ND, FUN NO, 1 Keys. Verify "FUNC:(1) ATC" Control Menu is displayed.

194. Adjust Pulse Generator delay for a reply delay reading of 3.0 µs (±0.5 µs).

195. Depress CMENU, 2 Keys. Verify Control Menu 2 is displayed.

196. Use CURSOR Keys (A) to move cursor to "PULSE POWER GATE" field.

197. Verify F_1 is displayed.

198. Record XMTR PWR WATTS Display (1).

199. Set F_2/P_2 F_1/P_1 Switch (34) to F_2/P_2.

200. Verify XMTR PWR WATTS Display (1) value has not changed from level recorded in step 199.

201. Rotate SLEW Control (F) until "X" is displayed in Pulse Power Gate field.

202. Verify XMTR PWR WATTS Display (1) displays 00.

203. Set Dual Pulse Generator spacing to 10.15 µs.

204. Verify XMTR PWR WATTS Display (1) displays value recorded in step 198.

205. Disconnect Pulse Generator.

RF Vernier Test

206. Connect RF Power Meter to RF I/O Connector (9).

207. Set CW/NORM/OFF Switch (7) to CW.

208. Depress RF LVL Key.

209. Enter 0.

210. Depress ENT Key.

211. Set RF Level (3) to -4 dBm.

212. Record Power Meter reading.

213. Rotate SLEW Control (F) to set RFLvl field to +3.0.

214. Verify RF Power Meter displays 3.0 dB (±0.2 dBm) greater than value recorded in step 212.

215. Rotate Slew Control (F) to set "RFLvl" field to -3.0.

Step	Procedure

216. Verify RF Power Meter displays 3.0 dB (±0.2 dBm) below reference value recorded in step 212.

ANT B RF LEVEL Test

217. Connect Spectrum Analyzer to RF I/O Connector (9).

218. Rotate RF Level Control (6) until Display (3) displays -50 dBm.

219. Rotate Slew Control (F) to set "RFLvl" field to +0.0.

220. Use CURSOR Keys (A) to position cursor in "ANT B:" field.

221. Depress ON/CAL Key until a numerical value is displayed.

222. Set Spectrum Analyzer display as reference.

223. Connect Spectrum Analyzer to ANT B Connector. Verify level is equal to reference ±1 dB.

224. Set CW/NORM/OFF Switch (7) to NORM.

ANT B Time Delay Test

225. Connect Test Setup per Figure 57.

226. Select 2ND, FUN NO, 1 Keys. Verify "FUNC: (1) ATC" Control Menu is displayed.

227. Set Oscilloscope for 2 µs per division resolution.

228. Use Δ time to record time from sync to P_1 of ATC-1400A.

229. Connect Heterodyne Monitor to TP31003.

230. Set ANT B to ON using 2nd, FUN No, ANT B, ON/CAL Keys.

231. Verify ANT B P_1 leading edge is coincident (±25 ns) of RF I/O P_1.

232. Enter 0.95 in ANT B: field.

233. Depress ENT Key.

234. Verify ANT B leading edge is shifted to +0.95 µs from original position.

235. Select +/- Key. Verify "ANT B:" field displays -0.95.

236. Verify ANT B Leading Edge is shifted -0.95 µs from original position.

237. Set ANT B delay to +0.00.

Step	Procedure

238. Depress 2ND, FUN NO, 2 Keys.

239. Monitor TP31003 using heterodyne monitor.

240. Verify P_1 Pulse Width is 0.8 µs (±10 ns).

241. Verify P_2 to SPR spacing is 2.75 µs (±50 ns).

MODE S/ATCRBS DISCRETE Test

242. Connect Oscilloscope Channel B to GEN Connector (15).

243. Depress 2ND, FUN NO, 5 Keys. Verify "FUNC:(5) INTLCE" Control Menu is displayed.

244. Depress CMENU, 2 Keys.

245. Use CURSOR Keys (A) to move cursor to PREPULSE field.

246. Depress ON/CAL Key until a numerical value is displayed.

247. Enter 0.

248. Connect ATCRBS/MODE S DISCRETE OUT (J10005) Connector (DD) to Oscilloscope Channel A, select int trigger Channel A, negative slope.

249. Verify 3.0 µs wide TTL Low-Level pulse occurs 1.0 µs prior to interrogation P_1.

250. Enter 3.

251. Verify interrogation P_1 has shifted position.

252. Verify Discrete Pulse position has remained constant.

OSCILLOSCOPE TRIGGER Test

253. Set DBL INTERR/INTERF PULSE Thumbwheels (42) to 200, DOUBLE.

254. Select 2ND, FUN NO, 6 Keys. Verify "FUNC:(6) DI" Control Menu is displayed.

255. Set PRF/SQTR Thumbwheels (41) to 100.

256. Utilize CURSOR Keys (A) to move cursor to "1st=" field.

257. Depress ON/CAL Key until ATC is displayed.

258. Utilize CURSOR Keys (A) to move cursor to "2ND =" field.

259. Depress ON/CAL Key until SEQ is displayed.

260. Set T_O/TAC/T_D Switch (30) to T_O.

Step	Procedure
261.	Connect SCOPE TRIG OUT (J10007) Connector (AA) to Oscilloscope Channel A. Select positive slope trigger.
262.	Verify first interrogation occurs 1.0 µs following SCOPE TRIG OUTPUT (J10007) Rising Edge.
263.	Verify Trigger Falling Edge occurs 2.0 µs following P_3 Leading Edge.
264.	Set T_O/TAC/T_D Switch (30) to T_D.
265.	Verify second interrogation occurs 1.0 µs following SCOPE TRIG OUTPUT Leading Edge.
266.	Verify SCOPE TRIG OUTPUT Trailing Edge occurs 127 µs following MODE S Interrogation SPR.
267	Select 2ND, FUN NO, 5 Keys. Verify "FUNC:(5) INTLCE" Control Menu is displayed.
268.	Set DBL INTERR/INTERF PULSE Thumbwheels to 200.0, OFF.
269.	Set T_O/TAC/T_D Switch (30) to T_O.
270.	Verify T_O Pulse Leading Edge occurs 1.0 µs before P_1 of 1st interrogation.
271.	Verify T_O Pulse Trailing Edge occurs 2.0 µs following P_3 Leading Edge.
272.	Set T_O/TAC/T_D Switch (30) to T_D.
273.	Verify T_D Pulse Leading Edge occurs 1.0 µs prior to Mode S interrogation P_1.
274.	Verify T_D Pulse Trailing Edge occurs 127 µs following MODE S interrogation SPR.

SECTION 3 - SPECIFICATIONS

1. MODE S TEST SYSTEM SPECIFICATIONS

NOTE: These specifications supersede ATC-1400A specifications whenever the ATC-1400A is mated to the S-1403. Refer to ATC-1400A Operation /Maintenance Manual Section 1-3-1 for specifications not outlined here.

A. CONTROL MENU FUNCTIONS

Mode Select:

ATC:	Selects ATCRBS pulse modulation (A, C, etc.). The S-1403 Test Auxiliary generates the pulses, measures Reply Delay and %Reply, and controls selective reply pulse power measurement for ATC Modes.
SEQ:	Mode S interrogations are provided from the S-1403 Test Auxiliary, which outputs the stored sequence.
ACS:	ATCRBS All-Call (Short). Outputs an ATCRBS interrogation plus a 0.8 µs P_4 pulse to disable Mode S transponder replies.
ACL:	ATCRBS/Mode S All-Call (Long). Outputs an ATCRBS interrogation plus a 1.6 µs P_4 pulse to enable an All-Call (DF11) reply.
INTLCE:	Sets ratio of Mode S to ATCRBS interrogations. Mode S interrogations are interlaced with a fixed delay of 200 µs from P_1 of the first (ATCRBS) interrogation.
DI:	Sets double interrogation modes (Any combination of ATCRBS, All-Call and Mode S). Enable and DI delay are controlled by ATC-1400A DBL INTERR/INTERF PULSE Thumbwheels (42). Variable pulse controls are valid for the first interrogation only.
BURST:	Programs the BURST Key to output ATC, ACS, ACL, or SEQ formats, followed by the BURST number value of 1 to 999.

B. PULSE CHARACTERISTICS

All pulse accuracies should be verified using a Heterodyne Monitor of the type shown in Appendix H, ATC-1400A Operation/Maintenance Manual. This includes amplitude, and phase transition measurements.

P_2 (SEQ) (ANT A and ANT B)

Position	Calibrated at 2.0 µs (±10 ns).
Deviation	±1.85 µs selectable in 0.05 µs increments. (ATC-1400A XPDR P_2/P_3 DEV Thumbwheels [44] and ATC-1400A XPDR DEV P_2/CAL Switch [28])
Accuracy:	±10 ns
Width	Calibrate 0.8 µs (±10 ns) (ATC-1400A XPDR PULSE WIDTH VAR/CAL Switch [20] in CAL position)
	Variable 0.20 µs to 1.85 µs (±10 ns) (ATC-1400A XPDR PULSE WIDTH VAR/CAL Switch [20] in VAR position)

P_3 (ATC, ACS, ACL) (ANT A and ANT B)

P_1-P_3 Mode Spacing (ATC, ACS, ACL)(ATC-1400A XPDR MODE Control [38])	3.0 µs ±10 ns (Mode 1) 5.0 µs ±10 ns (Mode 2) 6.5 µs ±10 ns (Mode T) 8.0 µs ±10 ns (Mode 3/A) 17.0 µs ±10 ns (Mode B) 21.0 µs ±10 ns (Mode C) 25.0 µs ±10 ns (Mode D)
Deviation	±1.85 µs selectable in 0.05 µs increments. (ATC-1400A XPDR DEV P_3/CAL Switch [25])
Accuracy:	±10 ns
Width	Calibrate 0.8 µs ±10 ns (ATC-1400A XPDR PULSE WIDTH VAR/CAL Switch [20] in CAL position)
	Variable 0.20 µs to 1.85 µs (±10 ns) (ATC-1400A XPDR PULSE WIDTH VAR/CAL Switch [20] in VAR position)

P_2 SLS :(ATC, ACL, ACS Functions)

ATC-1400A SLS/ECHO ON/OFF Switch (18) disables all other pulse amplitude control and enables P_2.

Width: Fixed at 0.8 µs. Variable 0.2 µs to 1.85 µs, in 50 ns steps)

Accuracy: ±10 ns

Position: For ATC, ACS and ACL, 2.0 µs from leading edge of P_1.

Accuracy: ±10 ns

Deviation ±1.85 µs selectable in 0.05 µs increments. (ATC-1400A XPDR P_2/P_3 DEV Thumbwheels [44] and ATC-1400A XPDR DEV P_2/CAL Switch [28])

Accuracy: ±10 ns

P_5 SLS: (SEQ Function)

ATC-1400A SLS/ECHO ON/OFF Switch (18) disables all other pulse amplitude control and enables P_5.

Width: Fixed at 0.8 µs.

Accuracy: ±100 ns

Position: For Mode S, fixed relationship to Sync Phase Reversal from -0.4 µs before SPR to +0.4 µs following SPR.

Accuracy: ±100 ns

Deviation Controlled by SPR deviation

P_4 Control: (ACS, ACL) (ANT A and ANT B)

All-Call Modes:

Width: Calibrated to 0.8 µs for P_4 (short) and 1.6 µs for P_4 (long). Variable independent of P_1, P_2 and P_3 from 0.2 µs to 2.75 µs in 0.05 µs steps for P_4 (short) and from 0.2 µs and 3.55 µs for P_4 (long).

Accuracy: Fixed and Variable = ±50 ns.

Deviation:

CAL (±0.0): =10 µs for ATCRBS Mode A (P_1 to P_4). =23 µs for ATCRBS Mode C (P_1 to P_4).

Variable: ±1.95 µs relative to CAL position in 0.050 µs steps.

Accuracy: ±10 ns.

P_6 Control (SEQ): (ANT A and ANT B)

Width: Calibrated at 16.25 µs or 30.25 µs (56 or 112 phase reversals). Variable ±1.5 µs in 0.05 µs steps.

Accuracy: ±50 ns

Deviation: CAL at 3.5 µs following P_1. Variable ±1.95 µs in 0.05 µs steps.

Accuracy: ±10 ns

Pulse Amplitude (P_2, P_3, P_4, P_2[SLS], P_5)

Variable from -19 to +6 dB in 1 dB steps using ATC-1400A SLS ECHO Thumbwheels (50)

Accuracy: Per ATC-1400A SLS Level specification except: ±0.3 dB for -10 dB to +3 dB.

Suppressor Pulse:

ATC Per ATC-1400A Specifications

SEQ 0.8 µs prior to SPR

ACS 0.8 µs prior to P_3

ACL 0.8 µs prior to P_3

DI Per ATC-1400A Specifications

Interference Pulse;

ATC, SEQ, ACS, ACL Per ATC-1400A Specifications.

SYNC Phase Reversal: (ANT A and ANT B)

Control:	ON/OFF
Deviation:	Calibrated at 2.75 µs after the rising edge of P_2(CAL). Variable from +1.75 µs to +3.75 µs, relative to the rising edge of P_2(CAL) in 50 ns steps (All DPSK data deviates accordingly).
Accuracy:	±50 ns

DPSK

Output Phase:	Switching >1.2 V P-P bipolar signal into 50 ohms
Phase Reversal Time:	<80 ns (10 to 170 degrees).

Reply Delay:

ATCRBS (ATC):	Measures delay from P_3 (CAL) to f1 (typically 3.0 µs) to a resolution of 25 ns.
Accuracy:	±100ns
Mode S (SEQ):	Measures delay from the SYNC Phase Reversal (CAL) to the first preamble pulse of the reply (typically 128 µs) to a resolution of 25 ns.
Accuracy:	±50 ns

%Reply:

ANT A (ATC), ATC:	0 to 127% in 1% steps.
ANT A (SEQ), S:	0 to 127% in 1% steps (Displays percent of valid Mode S replies only).
ANT B (ATC, SEQ):	Composite %Reply of 0 to 127% in 1% steps (Displays percent of valid replies that return through Antenna B).
Accuracy:	+/-1 step

Prepulse:	Positive pulse whose leading edge can be programmed from 0.0 µs to 260 µs in 1.0 µs steps prior to the leading edge of P1 of the interrogation. Active in all functions except ATC and DI.
EXT SYNC Out:	Positive pulse whose leading edge can be programmed to occur from -9.95 µs to +9.95 µs from the leading edge of P_1 of the interrogation in ±50 ns steps.
EXT SYNC In:	Positive TTL signal whose leading edge triggers the pulse output sequence. Not active in BURST Function
EXT MOD In:	Zero to 5 V signal used to drive the ATC-1400A modulator.
Decoder (SEQ):	Decodes downlink data and generates parity information which is compared to the "AP" field to check errors.
Squitter (ATC):	Indicates Squitter period from 0.0 to 9.99 seconds in 10 ms steps.
Accuracy:	±10 ms
Address:	Mode S address selectable from 1 to 2 to the 24th power.
	NOTE: When the address is entered, parity is generated according to RTCA specification DO-181; Mar. 1983, Section 2.2.16.2.1.
Pulse Power Measurement Gate (ATC, SEQ):	Positive TTL signal occuring 0.35 µs prior to the selected pulse.

C. ADDITIONAL FUNCTIONS

Pulse Repetition Frequency Limitations:

FUNCTION	MAXIMUM PRF Without replies*	With replies
ATC	850	1500
SEQ	200	200
ACS	800	1500 ATC 200 Mode S
ACL	200	200
INTLCE	500	500 (1:3 or less [200 for Mode S]) 400 (1:2) 200 (1:1)
DI ATC;ATC All others	500	750 100
BURST	Refer to figure 1. Number limit computed by Limit = [Interger value of (3.27 ms X PRF)] + 1.0	
*Without replies in ATC, ACS and DI functions, erroneous indications occur above value listed.		

Table 1 PRF Limitations

RF Level: "RFLvl" Key followed by a number or ATC-1400A RF LEVEL Control (6) entry will raise or lower the ATC-1400A RF level by 3 dB in ±0.1 dB steps.

Accuracy: ±10%

Ant B:

Control: OFF/(delay value) Used to enable or disable the second RF output for diversity testing and to set the delay of Channel B's output from Channel A.

Frequency: 1030 MHz

Accuracy: 0.001%

RF Level: -50 dBm

Accuracy: ±1 dB relative to the output of the ATC-1400A at -50 dBm.

Delay: Variable 0.95 µs in 0.05 µs steps.

Phase Reversal

Transition: <80 ns (10 to 170 degrees)

ANT A to ANT B
Tracking Accuracy: ±25 ns

Pulse Amplitude: No variable level capability.

Mode S/ATCRBS Discrete Output:

ATCRBS: - TTL low-level pulse; Occurs 1.0 µs prior to Prepulse for 3.0 µs.

Mode S: - TTL high-level.

Active for all functions except ATC and DI.

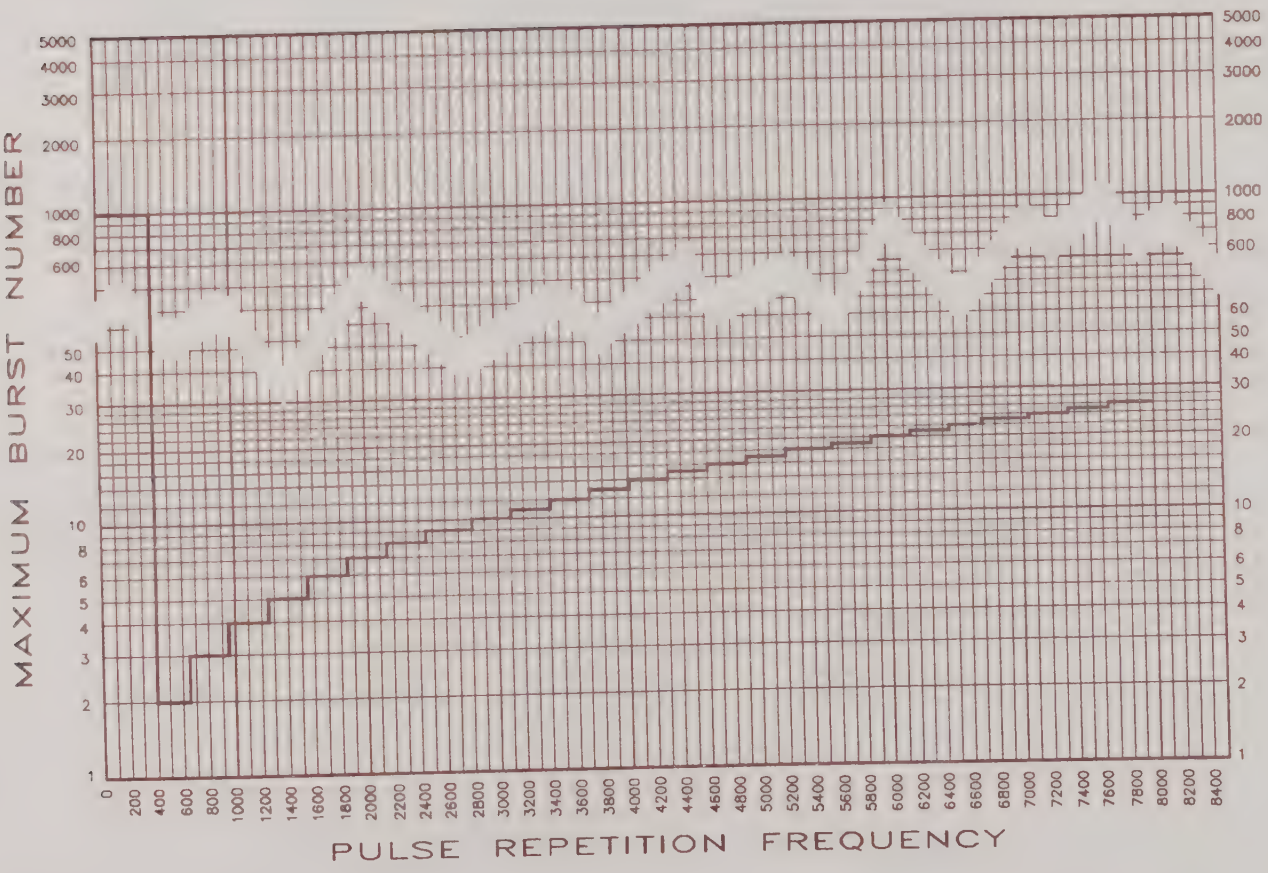

Figure 1 - Burst Test Function PRF Limitations

Scope Trigger (J10007):

ATC:	t0	Rising edge occurs 1.0 µs prior to P_1, falling edge 1.0 µs prior to P_3.
	td	Rising edge is 3.0 µs following P3, falling edge 23.3 µs following P3.
SEQ:	t0	Rising edge is 1.0 µs prior to P1. Falling edge occurs 1.0 µs prior to SPR (CAL)
	td	Rising edge is 127 µs following SPR (CAL), falling edge is 8.0 µs later.
ACS:	t0	Rising edge is 1.0 µs prior to P_1. Falling edge occurs 1.0 µs prior to P4(CAL).
	td	Rising edge is 1.0 µs prior to first pulse of the reply. Falling edge is 0.8 µs later.
ACL:	t0	Rising edge is 1.0 µs prior to P_1 leading edge. Falling edge occurs 1.0 µs prior to P_4(CAL).
	td	Rising edge is 1.0 µs prior to the first pulse of the reply. Falling edge occurs 0.8 µs later.
INTLCE:	t0	Leading edge is 1.0 µs prior to the leading edge of the ATCRBS interrogation P_1. Falling edge is 3.0 µs following P_3 of the interrogation.
	td	Leading Edge is 1.0 µs prior to the leading edge of P_1 of the Mode S interrogation. Falling edge occurs 132.75 µs later.

DI:	t0	(first interrogation sequence) Leading edge is 1.0 µs prior to the leading edge of first interrogation P_1. Falling edge occurs 3.0 µs later for ATCRBS and 132.75 µs later for Mode S.
	td	(second interrogation sequence) Leading edge is 3.0 µs prior to the leading edge of second interrogation P_1. Falling edge occurs 3.0 µs later for ATCRBS and 132.75 µs later for Mode S.
BURST:		See ATC through ACL.

D. POWER REQUIREMENTS

AC Input:	105 to 120/220 to 250 VAC, 50 to 400 Hz, 40 Watts
AC Output:	Line output, fused at 3 Amps and switched.

SECTION 4 - PACKING FOR SHIPMENT

1. GENERAL

The following information applies to shipping and packing procedures for the S-1403.

A. Shipping Information

IFR test sets returned to factory for calibration, service or repair must be packaged and shipped subject to the following conditions:

(1) Do not return any products to factory without first receiving authorization from IFR Customer Service Department.

CONTACT:

Customer Service Dept.
IFR Systems, Inc.
10200 West York Street
Wichita, Kansas 67215

Telephone: (800) 835-2350
TWX: 910-741-6952

(2) All test sets must be tagged with:

(a) Owner's identification and address.
(b) Nature of service or repair required.
(c) Model No.
(d) Serial No.

(3) Sets must be packaged in original shipping containers using IFR packing models. If original shipping containers and materials are not available, contact IFR's Customer Service Dept. for shipping instructions.

(4) All freight costs on non-warranty shipments are assumed by customer. (See "Warranty Packet" for freight charge policy on warranty claims.)

B. Packing Procedure

(1) Make sure bottom packing mold is seated on floor of shipping container.

(2) Carefully wrap test set with polyethylene sheeting to protect finish.

(3) Place test set into shipping container, making sure set is securely seated in bottom packing mold.

(4) Place top packing mold over top of set and press down until mold rests solidly on bottom packing mold.

(5) Close shipping container flaps and seal with shipping tape or an industrial stapler. Tie all sides of container with break resistant rope, twine or equivalent.

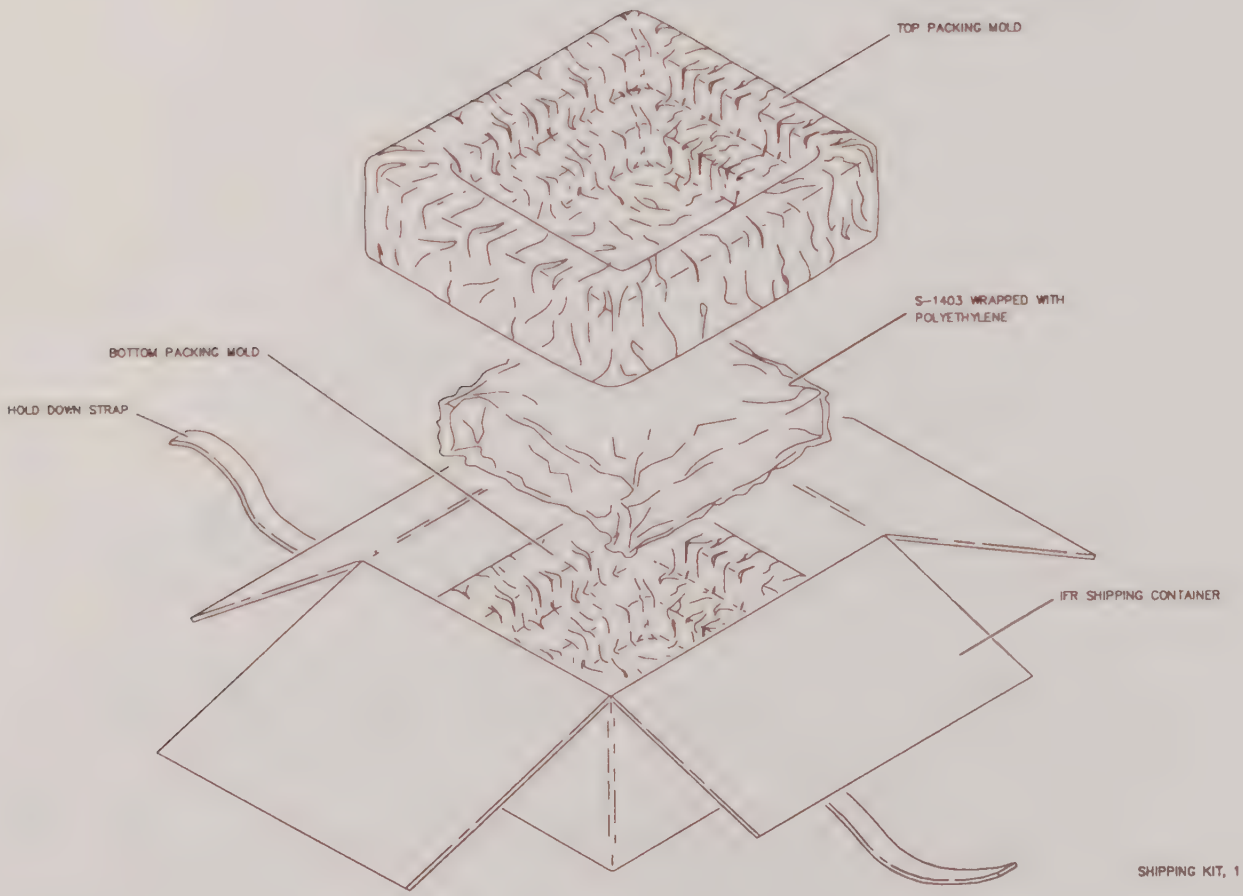

Figure 1 - Packing Procedure

SECTION 5 - STORAGE

1. GENERAL

While there are no special requirements for extended storage periods, please observe the following storage precautions.

A. Disconnect the Test Set from any electrical power source.

B. Disconnect and store the AC power cable and any other accessories used exclusively with the Test Set.

C. Cover the Test Set to prevent dust and debris from covering and settling on the Test Set.

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APPENDIX A - CONNECTOR PIN-OUT TABLES

PULSE PC BOARD ASSEMBLY			
CONNECTOR PIN NUMBER	SIGNAL TYPE	SIGNAL	INPUT/OUTPUT
J10003	EXT MOD	TTL	INPUT
J10004	EXT SYNC	TTL	INPUT
J10005	ATCRBS DISC	TTL	OUTPUT
J10006	BVIDEO	TTL	OUTPUT
J10007	SCOPE TRIG	TTL	OUTPUT
J10008	EXT SYNC	TTL	OUTPUT
J10009	PREPULSE	TTL	OUTPUT
J10010	AUXILIARY	VARIOUS	INPUT/OUTPUT
J10013	RF VERNIER	0 TO 7 VDC	OUTPUT
J10014	MEASURE GATE	TTL	OUTPUT
J10015	DPSK	BIPOLAR	OUTPUT
PROCESSOR PC BOARD ASSEMBLY			
J10011	IFR BUS	TTL	INPUT/OUTPUT
J10012	TEST	RS-232C	INPUT/OUTPUT
FRONT PANEL			
J10001	UUT XMTR	50 OHMS	OUTPUT
J10002	ANT B	50 OHMS	INPUT/OUTPUT

AUXILIARY J10010 (J6 ATC-1400A)				
PIN NUMBER	SIGNAL NAME	SIGNAL TYPE	INPUT/OUTPUT	POLARITY
1	GROUND			
2	SPARE			
3	SPARE			
4	SPARE			
5	EXT PULSE	TTL	OUTPUT	ACTIVE LOW
6	EXT SLS	TTL	OUTPUT	ACTIVE LOW
7	SPARE			
8	PULSE	TTL	INPUT	POSITIVE
9	20 MHz	TTL	INPUT	RISING EDGE
10	SPARE			
11	50% VIDEO	TTL	INPUT	POSITIVE
12	SPARE			
13	SPARE			
14	SELF INTERROGATE	TRISTATE	INPUT/OUTPUT	RISING EDGE
15	GROUND			
16	GROUND			
17	GROUND			
18	GROUND			
19	GROUND			
20	GROUND			
21	GROUND			
22	GROUND			
23	SPARE			
24	GROUND			
25	SPARE			

IFR BUS J10011 (J5 ATC-1400A)				
PIN NUMBER	SIGNAL NAME	SIGNAL TYPE	INPUT/OUTPUT	POLARITY
1	GROUND			
2	A0	TTL	INPUT	POSITIVE
3	A1	TTL	INPUT	POSITIVE
4	GROUND			
5	A2	TTL	INPUT	POSITIVE
6	D7	TTL	INPUT/OUTPUT	POSITIVE
7	D6	TTL	INPUT/OUTPUT	POSITIVE
8	A3	TTL	INPUT	POSITIVE
9	GROUND			
10	GROUND			
11	NOT USED			
12	D5	TTL	INPUT/OUTPUT	POSITIVE
13	GROUND			
14	NOT USED			
15	D4	TTL	INPUT/OUTPUT	POSITIVE
16	GROUND			
17	WRITE	TTL	INPUT	POS STROBE
18	D3	TTL	INPUT/OUTPUT	POSITIVE
19	GROUND			
20	READ	TTL	INPUT	POS STROBE
21	D2	TTL	INPUT/OUTPUT	POSITIVE
22	INTA	OC	OUTPUT	ACTIVE LOW
23	INTR	OC	INPUT	ACTIVE LOW
24	D1	TTL	INPUT/OUTPUT	POSITIVE
25	D0	TTL	INPUT/OUTPUT	POSITIVE

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APPENDIX B - MODE S TEST SYSTEM DATA TRANSMISSION FORMATS

FORMAT NAME	DECIMAL FORMAT NUMBER	SEQUENCE MENU NUMBER	BINARY FORMAT NUMBER (BITS 1-5)	FIELD (BIT) DEFINITION*
Short Special Surveillance	00	S01	00000	Bits 6-8: OPEN 9: RL 10-13: OPEN 14: AQ 15-32: OPEN 33-56: AP
Surveillance Altitude Request	04	S02	00100	Bits 6-8: PC 9-13: RR 14-16: DI 17-32: SD 33-56: AP
Surveillance Identity Request	05	S03	00101	Bits 6-8: PC 9-13: PR 14-16: DI 17-32: SD 33-56: AP
Mode S Only All-Call	11	S04	01011	Bits 6-9: PR 10-13: II 14-32: "1"'s 33-56: AP
Long Special Surveillance	16	S05	10000	Bits 6-8: OPEN 9: RL 10-13: OPEN 14: AQ 15-32: OPEN 33-88: MU 89-112: AP
Comm-A, Altitude Surveillance	20	S06	10100	Bits 6-8: PC 9-13: RR 14-16: DI 17-32: SD 33-88: MA 89-112: AP

Overview of Mode S Interrogation (Uplink) Formats
Table B-1

FORMAT NAME	DECIMAL FORMAT NUMBER	SEQUENCE MENU NUMBER	BINARY FORMAT NUMBER (BITS 1-5)	FIELD (BIT) DEFINITION*
Comm-A, Identity Request	21	S07	10101	Bits 6-8: PC 9-13: RR 14-16: DI 17-32: SD 33-88: MA 89-112: AP
Unspecified (Short)	01 02 03 06 07 08 09 10 12 13 14 15		00001 00010 00011 00110 00111 01000 01001 01010 01100 01101 01110 01111	Bits 6-32: OPEN 35-56: AP
Unspecified (Long)	17 18 19 22 23		10001 10010 10011 10110 10111	Bits 6-88: OPEN 89-112: AP

*Refer to Appendix E for explanation of these bit definitions.

OVERVIEW OF MODE S INTERROGATION (UPLINK) FORMATS
TABLE B-1 (CONT)

FORMAT NAME	DECIMAL FORMAT NUMBER	SEQUENCE MENU NUMBER	BINARY FORMAT NUMBER (BITS 1-5)	FIELD BIT DEFINITION*
Short Special Surveillance	00	S01	00000	Bits 6: VS 7-15: OPEN 16-17: RI 18-19: OPEN 20-32: AC 33-56: AP
Surveillance Altitude	04	S02	00100	Bits 6-8: FS 9-13: DR 14-19: UM 20-32: AC 33-56: AP
Surveillance Identity	05	S03	00101	Bits 6-8: FS 9-13: DR 14-19: UM 20-32: ID 33-56: AP
All Call Reply	11	S04	01011	Bits 6-8: CA 9-32: AA 33-56: PI
Long Special Surveilance	16	S05	10000	Bits 6: VS 7-13: OPEN 14-17: RI 18-19: OPEN 20-32: AC 33-88: MV 89-112: AP
Comm-B, Altitude	20	S06	10100	Bits 6-8: FS 9-13: DR 14-19: UM 20-32: AC 33-88: MB 89-112: AP
Comm-B, Identity	21	S07	10101	Bits 6-8: FS 9-13: DR 14-19: UM 20-32: ID 33-88: MB 89-112: AP

OVERVIEW OF MODE S REPLY (DOWNLINK) FORMATS
TABLE B-2

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APPENDIX C - TEST EQUIPMENT REQUIREMENTS

1. General.

This appendix and Appendix J, ATC-1400A Operation/ Maintenance Manual, contains a list of test equipment suitable for performing all of the maintenance procedures contained in this manual. Any other equipment meeting the specifications listed in these appendices may be substituted in place of the recommended models.

2. Recommended Test Equipment

TYPE	MANUFACTURER AND MODEL	SPECIFICATIONS
COAXIAL DETECTOR	Hewlett Packard 423A	Frequency Range: 10 MHz to 12.4 GHz Response 0.2 dB Output Impedance: <15 kΩ shunted to 10 pF
SIGNAL GENERATOR	Hewlett Packard 8640B	Frequency Range: 1 to 1030 MHz Resolution: 0.1 to 100 Hz Accuracy: 2 X 10^{-6} RF Output: 13 to -130 dBm
VECTOR VOLTMETER	Hewlett Packard 8405A	Phase Accuracy: 1.5°
SPECTRUM ANALYZER	IFR A-8000	Frequency Range: 10 kHz to 2.6 GHz Resolution Bandwidth: 300 Hz to 3.0 MHz

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APPENDIX D - ABBREVIATIONS

A

AA	Address Announced
AC	Altitude Code
AC	Alternating Current
ACL	All Call Long
ACS	All Call Short
ADS	A-Definition Subfield
AM	Amplitude Modulation
ANT	Antenna
AP	Address Parity
APERROR	AP Error
AQ	Acquisition Special
ASCII	American Standard Code for Information Interchange
ATC	Air Traffic Control
ATCRBS	Air Traffic Control RADAR Beacon System
ATE	Automatic Test Equipment

B

BDS	B-Definition Subfield
BPulse	Diversity Pulse
BR	Bridge Rectifier
BT	Battery
BVideo	Diversity Video

C

CA	Capability
CAL	Calibrated Position
CAS	Column Address Strobe
CDS	C-Definition Sub-field
CFS	Continuation Sub-field
CH	Channel
CMENUn	Control Menu
CR	Diode

D

dB	Decibel
dBm	Decibels compared to 1 milliwatt.
DDS	D-Definition Sub-field
DEV	Deviation
DF	Downlink Format
DFSQnn	Downlink Format Sequence Number
DI	Designator Identification
DI	Double Interrogation
DISC	Discrete
DMA	Direct Memory Access
DME	Distance Measuring Equipment
DPSK	Differential Phase Shift Keying
DR	Downlink Request
Dv	Deviation

	E
ECS	Extended Capability Sub-field
ELM	Extended Length Message
ENT	Enter
ERRM	Error Message
ESC	Escape
EXMOD	External Modulation
EXSYN	External Synchronization
ExtSync	External Synchronous Fields
Ext M	External Mode
	F
FET	Field Effect Transistor
FIFO	First In First Out
FIS	Flight Identification Sub-field
FMT	Format
FS	Flight Status
Fun	Function
FUNC	Function
	G
GPIB	General Purpose Interface Bus
	H
Hz	Hertz
	I
ID	Identification (4906 Code)
IDS	Identifier Designator Sub-field
IFR	IFR Systems, Inc
II	Interrogator Identification
IIS	Interogator Identification Sub-field.
INTERF	Interference
INTERR	Interrogation
INTERRF	Interference
INTLCE	Interlace
	J
JTB	Jumper Terminal Block
	K
KE	Control, ELM
kHz	Kilo-Hertz (10^3)
kts	Knots (Velocity)
	L
LC	Inductor-Capacitor
LCA	Logic Cell Array
LCD	Liquid Crystal Display
LOS	Lockout Sub-field
LVL	Level
	M
MA	Message, COMM-A
MB	Message, COMM-B
MBS	Multi-site COMM-B Sub-field
MC	Message, COMM-C
MD	Message, COMM-D

MES	Multi-site ELM Sub-field
MHz	Mega-hertz (10^6)
ms	Milli-second (10^{-3})
MU	Message, COMM-U
MV	Message, COMM-V
	N
NC	Number of C-Segment
ND	Number of D Segment
ns	Nano-second (10^{-9})
	O
O'scope	Oscilloscope
	P
PC	Protocol
PC	Printed Circuit
PI	Parity/Interrogator Identity
PPG	Pulse Power Gate
PPM	Pulse Position Modulation
PPMG	Pulse Position Modulated Gate
PPMG	Pulse Power Measurement Gate
PPuls	Pre Pulse
PR	Probability of Reply
PRF	Pulse Repetition Frequency
Prply	Percent Reply
PWR	Power
	Q
	R
RAM	Random Access Memory
RAS	Row Address Strobe
RC	Reply Control
RC	Resistor-Capacitor
RCVDATA	Receive Data
RECALLn	Recall Number
RF	Radio Frequency
RFLvl	RF Level
RI	Reply Information, Air-to-Air
RL	Reply Length
ROM	Read Only Memory
RpDly	Reply Delay
RR	Reply Request
RRS	Reply Request Sub-field
RSS	Reservation Status Sub-field
RTCA	Radio Technical Commission for Aeronautics
	S
SAVEn	Save (number)
SD	Special Designator
Seq	Sequence
SEQAD	Sequence Address
SEQn	Sequence Number
SLS	Side Lobe Suppression
SMENU	Sequence Menu
SPR	Synchronous Phase Reversal
SQADD	Squitter Address

SQnn	Squitter Sequence Item Number
Sqtr	Squitter Fields
SRQ	Service Request
SRS	Segment Request Sub-field
SYNC	Synchronous
	T
T	Transformer
TAC	TACAN
TCXO	Temperature Compensated Crystal Oscillator
T_D	Reply Sync
TMS	Tactical Message Sub-field
T_O	Interrogation
Trig	Trigger
TTL	Transistor Transistor Logic
	U
UF	Uplink Field
UM	Utility Message
UUT	Unit Under Test
	V
VAC	Volts Alternating Current
VAR	Variation
VCO	Voltage Controlled Oscillator
VDC	Volts Direct Current
VRAM	Video Random Access Memory
VS	Vertical Status
	W
W	Watts
Wd	Width
	X
XMIT	Transmit
XMTR	Transmitter
XPDR	Transponder
	Y
	Z

APPENDIX E - SIGNAL FORMATS

1. Signal Formats

Signal formats for both Uplink and Downlink messages are outlined in Chapter 2, RTCA DO-181. Tables 1, 2, and 3 contain most, but not all, explanations of signals and their meanings.

2. Mode S Message Content

A. Address/Parity (Field AP)

All discrete Mode S interrogations (56-bit or 112-bit) and replies (except the All-Call reply) contain the 24-bit discrete address of the Mode S transponder upon which 24 error-detecting parity check bits are overlaid. In the All-Call reply, the 24 parity check bits are overlaid on the Mode S interrogator's address and the transponder's discrete address is included in the text of the reply.

B. Surveillance

The primary function of Mode S is surveillance. For the Mode S transponder, this function can be accomplished by the use of "short" (56-bit) transmissions in both directions. In these transmissions, the aircraft reports its altitude (DF04) or ATCRBS 4096 code as well as its flight status (airborne, on the ground, alert, Special Position Identification [SPI], etc.).

C. Data Link Communications

The discrete addressing and digital encoding of Mode S transmissions permit their use as a digital data link. The interrogation and reply formats of the Mode S system contain sufficient coding space to permit the transmission of data. Most Mode S data link transmissions will be handled as one 56-bit message included as part of "long" 112-bit interrogations or replies. These transmissions include the message in addition to surveillance data, and thus will generally be used in place of, rather than in addition to, a surveillance interrogation and/or reply.

An efficient transmission of longer messages is accomplished by the extended length message (ELM) capability (UF24 and DF24). Using this capability, a sequence of up to sixteen 80-bit message segments (each with a 112-bit transmission) can be transmitted, either ground-to-air or air-to-ground and can be acknowledged with a single reply/interrogation. ELMs do not contain surveillance data and thus cannot substitute for a surveillance interrogation-reply cycle.

3. Operating Goals

Mode S is a combined secondary surveillance radar and a potential ground-air-ground data link system capable of providing aircraft surveillance and communications necessary to support automated ATC in the dense traffic environments expected in the future. It is capable of common-channel interoperation with the ATC beacon system, and thus may be implemented over an extended ATCRBS-to-Mode S transition period. In supporting ATC automation, Mode S is capable of providing the reliable communications necessary for data link services.

Format No.	UF	
0	(0 0000) (RL:1)-3-(RL:4)--4--(AQ:1)--18-- (AP:24)	. . . . Short Special Surveillance
1	(0 0001)----------27----------(AP:24)	
2	(0 0010)----------27----------(AP:24)	
3	(0 0011)----------27----------(AP:24)	
4	(0 0100) (PC:3) (RR:5) (DI:3) (SD:16) (AP:24)	. . . . Surveillance, Altitude Request
5	(0 0101) (PC:3) (RR:5) (DI:3) (SD:16) (AP-24)	. . . . Surveillance, Identity Request
6	(0 0110)----------27----------(AP:24)	
7	(0 0111)----------27----------(AP:24)	
8	(0 1000)----------27----------(AP:24)	
9	(0 1001)----------27----------(AP:24)	
10	(0 1010)----------27----------(AP:24)	
11	(0 1011) (PR:4) (II:4) (--19 one's--) (AP:24)	. . . . . Mode S Only All-Call Reply
12	(0 1100)----------27----------(AP:24)	
13	(0 1101)----------27----------(AP:24)	
14	(0 1110)----------27----------(AP:24)	
15	(0 1111)----------27----------(AP:24)	
16	(1 0000) -3- (RL:1) --4-- (AQ:1) --18-- (MU:56) (AP:24)	. . Long Special Surveillance
17	(1 0001)----------83----------(AP:24)	
18	(1 0010)----------83----------(AP:24)	
19	(1 0011)----------83----------(AP:24)	
20	(1 0100) (PC:3) (RR:5) (DI:3) (SD:16) (MA:56) (AP:24)	. . Comm-A, Altitude Request
21	(1 0101) (PC:3) (RR:5) (DI:3) (SD:16) (MA:56) (AP:24)	. . Comm-A, Identity Request
22	(1 0110)----------83----------(AP:24)	
23	(1 0111)----------83----------(AP:24)	
24	(11) (RC:2) (NC:4) (MC:80) (AP:24)	. . Comm-C (ELM)

Notes:

(1) (XX:M) denotes a field designated "XX" which is assigned M bits.

(2) ---N--- denotes free coding space with N available bits.

(3) For uplink formats (UF) 0 through 23, the format number corresponds to the binary code in the first 5 bits of the interrogation. Format number 24 is arbitrarily defined as the format beginning with "11" in the first two bit positions while the following three bits vary with the interrogation content.

(4) All formats are shown for completeness, although a number of them are unused.

OVERVIEW OF MODE S INTERROGATION FORMATS
Table E-1

Format No.	DF	
0	(0 0000) (VS:1) -7- (RI:4)--2--(AC:13) (AP:24)	. . . . . Short Special Surveillance
1	(0 0001)----------27----------(AP:24)	
2	(0 0010)----------27----------(AP:24)	
3	(0 0011)----------27----------(AP:24)	
4	(0 0100) (FS:3) (DR:5) (UM:6) (AC:13) (AP:24)	. . . . Surveillance, Altitude Request
5	(0 0101) (FS:3) (DR:5) (UM:6) (ID:13) (AP-24)	. . . . Surveillance, Identity Request
6	(0 0110)----------27----------(AP:24)	
7	(0 0111)----------27----------(AP:24)	
8	(0 1000)----------27----------(AP:24)	
9	(0 1001)----------27----------(AP:24)	
10	(0 1010)----------27----------(AP:24)	
11	(0 1011) (CA:3) (AA:24) (AP:24)	. . . . . All-Call Reply
12	(0 1100)----------27----------(AP:24)	
13	(0 1101)----------27----------(AP:24)	
14	(0 1110)----------27----------(AP:24)	
15	(0 1111)----------27----------(AP:24)	
16	(1 0000) (VS:1) -7- (RI:4)--2--(AC:13) (MV:56) (AP:24)	. . Long Special Surveillance
17	(1 0001)----------83----------(AP:24)	
18	(1 0010)----------83----------(AP:24)	
19	(1 0011)----------83----------(AP:24)	
20	(1 0100) (FS:3) (DR:5) (UM:6) (AC:13) (MB:56) (AP:24)	. . Comm-B, Altitude Request
21	(1 0101) (FS:3) (DR:5) (UM:6) (ID:13) (MB:56) (AP:24)	. . Comm-B, Identity Request
22	(1 0110)----------83----------(AP:24)	
23	(1 0111)----------83----------(AP:24)	
24	(11) (KE:1) (ND:4) (MD:80) (AP:24)	. . Comm-D (ELM)

Notes:

(1) (XX:M) denotes a field designated "XX" which is assigned M bits.

(2) ---N--- denotes free coding space with N available bits.

(3) For uplink formats (UF) 0 through 23, the format number corresponds to the binary code in the first 5 bits of the interrogation. Format number 24 is arbitrarily defined as the format beginning with "11" in the first two bit positions while the following three bits vary with the interrogation content.

(4) All formats are shown for completeness, although a number of them are unused.

OVERVIEW OF MODE S REPLY FORMATS
Table E-2

FIELD	SUB FIELD	BITS NO.	BITS POSITION	FORMATS UP	FORMATS DOWN	CONTENT
AA		24	9-32		X	This 24-bit (9-32) downlink field contains the aircraft address in the clear and is used in DF=11, the All-Call reply.
AC		13	20-32		X	This 13-bit (20-32) downlink field contains the altitude code and is used in formats DF=0, 4, 16, and 20. ZERO is transmitted in each of the 13 bits if altitude information is not available. Metric altitude is contained in this field if the M-bit (26) is ONE.
AP		24 24	33-56 89-112	X	X	This 24-bit field (33-56 or 89-112) contains parity overlaid on the address and appears at the end of all transmissions on both uplink and downlink with the exception of format DF=11.
AO		1	14	X		This 1-bit field (14) designates formats UF=0, 16 as acquisition transmissions and is repeated as received by the transponder in DF=0, 16.
CA		3	6-8		X	This 3-bit (6-8) downlink field reports transponder capability and is used in DF=11, the All-Call reply. The codes are: 0 = No extended capability report. 1 = Comm-A/B and extended capability report. 2 = Comm-A/B/C and extended capability report. 3 = Comm-A/B/C/D and extended capability report. 4-7 = Not assigned.
CL		1	10	X		This 1-bit (10) subfield appears in special surveillance formats UF=0, 16. It indicates that TCAS has generated a resolution advisory with respect to the interrogated threat. The codes are: 0 = TCAS has not generated a resolution advisory. 1 = TCAS has generated a resolution advisory.
DF		5	1-5		X	The first field in all downlink formats is the transmission descriptor.
DI		3	14-16	X		This 3-bit (14-16) uplink field identifies the coding contained in the SD field in formats UF=4, 5, 20, 21. The codes are: 0 = SD not used. 1 = SD contains multisite information. 2-6 = Not assigned. 7 = SD contains extended data readout request.
DR		5	9-13		X	This 5-bit (19-13) downlink field is used to request extraction of downlink messages from the transponder by the interrogator and appears in formats DF=4, 5, 20, 21. The codes are: 0 = No downlink request. 1 = Request to send Comm-B message (B bit set) 2-15 = Not assigned. 16-31 = See Comm-D protocol. Codes 1-15 take precedence over codes 16-31.

OVERVIEW OF FORMAT DEFINITIONS
Table E-3

FIELD	SUB FIELD	BITS NO.	BITS POSITION	FORMATS UP	FORMATS DOWN	CONTENT
FS		3	6-8		X	This 3-bit (6-8) downlink field reports the flight status of the aircraft and is used in formats DF=4, 5, 20, 21. The codes are:
ID		13	2-32		X	This 13-bit (20-32) downlink field in DF=5, 21 contains the 4096 identification code reporting the numbers as set by the pilot.
II		4	10-13	X		This 4-bit (10-13) uplink field identifies the interrogator and appears in UF=11, the Mode S-Only All-Call.
KE		1	4		X	This 1-bit (4) downlink field defines the content of the MD and MD fields in Comm-D replies, DF=24.
MA		56	33-88	X		This 56-bit (33-88) uplink field contains messages directed to the aircraft and is part of Comm-A interrogations, UF=20, 21. The field contains the 8-bit Comm-A Definition Subfield ADS.
	ADS	8	33-40	X		This 8-bit (33-40) uplink subfield defines the content of the MA message field of which it is part. ADS is expressed in two groups of 4 bits each, ADS1 (33-36) and ADS2 (37-40).
MB		56	33-88		X	This 56-bit (33-88) downlink field contains messages to be transmitted to the interrogator and is part of the Comm-B replies DF=20, 21. The field contains the 8-bit Comm-B Definition Subfield BDS.
	ACS	20	45-64		X	This 20-bit (45-64) Comm-A capability subfield reports the data link service(s) supported by this installation. If all bits are ZERO, no Comm-A data link services are supported.
	BCS	16	65-80		X	This 16-bit (65-80) Comm-B capability subfield reports the ground for transmission via a ground-initiated Comm-B. If all bits are ZERO, no data is accessible by a ground initiated Comm-B.
	BDS	8	33-40		X	This 8-bit (33-40) downlink subfield defines the content of the MB message field of which it is part. BDS is expressed in two groups of 4 bits each, BDS1 (33-36) and BDS2 (37-40).
	BDS2	4	37-40			BDS2 is a 4-bit (37-40) subfield. The basic report uses BDS2=0. More complex Mode S installations report their additional capabilities in various formats assigned to BDS2 codes other than ZERO.
	CFS	4	41-44		X	This 4-bit (41-44) continuation subfield contains the BDS2 value of the next additional capability report available from this installation.

Code	Alert	SPI	Airborne	On the Ground
0	no	no	yes	no
1	no	no	no	yes
2	yes	no	yes	no
3	yes	no	no	yes
4	yes	yes	either	
5	no	yes	either	

6, 7 are not assigned

NOTE: The same information also may appear in the IIS subfields.

OVERVIEW OF FORMAT DEFINITIONS
Table E-3 Cont'd

FIELD	SUB FIELD	BITS NO.	BITS POSITION	FORMATS UP	FORMATS DOWN	CONTENT
	ECS	8	81-88		X	This 8-bit (81-88) extended capability subfield reports the ELM capability of the installation. If all bits are ZERO, no ELM data link services are supported.
	FIS	48	41-88		X	If a surveillance or Comm-A interrogation (UF=4, 5, 20, 21) contains RR=18 and DI other than 7, the transponder shall reports its flight identification number in the 48-bit (41-88) FIS subfield in MB.
MC		80	9-88	X		This 80-bit (9-88) uplink field contains one segment of a sequence of segments transmitted to the transponder in the ELM mode. MC is part of UF=24.
	CDS	8	9-16	X		This 8-bit (9-16) uplink subfield defines the message to be sent to the transponder and is included in segment zero of an ELM uplink sequence.
	SRS	16	9-24	X		If a Comm-C interrogation (JF=24) contains RC=3, it also contains a list of segment request-authorizations in the 16-bit (9-24) SRS subfield. Starting with bit 9, which denotes the first segment, each of the following bits is set to ONE if the transmission of the corresponding segment is requested.
MD		80	9-88		X	This 80-bit (9-88) downlink field contains one segment of a sequence of segments transmitted by the transponder in the ELM mode. It may also contain a summary of received MC segments of an uplink ELM. MD is part of DF=24.
	DDS	8	9-16		X	This 8-bit (9-16) downlink subfield defines the message to be transmitted and is included in segment zero of an ELM downlink sequence.
	TAS	16	17-32		X	This 16-bit (17-32) downlink subfield in MD shall report the segments received so far in a Comm-C sequence. Starting with bit 17, which denotes number "0", each of the following bits is ONE if the corresponding segment of the sequence has been received. TAS appears in MD if KE=1 in the same reply.
MU		56	33-88	X		This 56-bit (33-88) downlink field contains information used in air-to-air exchanges and is part of the long special surveillance interrogation UF=16. This message field does not follow the Comm-B protocol.
MV		56	33-88		X	This 56-bit (33-88) downlink field contains information used in air-to-air exchanges and is part of the long special surveillance interrogation DF=16. This message field does not follow the Comm-B protocol.
NC		4	5-8	X		This 4-bit (5-8) uplink field gives the number of a segment transmitted in an uplink ELM and is part of a Comm-C interrogation, UF=24.
ND		4	5-8		X	This 4-bit, (5-8) downlink field gives the number of a segment transmitted in a downlink ELM and is part of a Comm-D reply, DF=24.

OVERVIEW OF FORMAT DEFINITIONS
Table E-3 Cont'd

FIELD	SUB FIELD	BITS NO.	BITS POSITION	FORMATS UP	FORMATS DOWN	CONTENT
PC		3	6-8	X		This 3-bit (6-8) uplink field contains operating commands to the transponder and is part of surveillance and Comm-A interrogations UF=4, 5, 20, 21. The codes are: 0 = No changes in transponder state. 1 = Non-selective All-Call lockout. 2 = Not assigned. 3 = Not assigned. 4 = Cancel B 5 = Cancel C 6 = Cancel D 7 = Not assigned.
PI		24	33-56		X	This 24-bit (33-56) downlink field contains the parity overlaid on the interrogator's identity code. PI is part of the reply to the Mode S-Only All-Call, DF=11.
PR		4	6-9	X		This 4-bit (6-9) uplink field contains commands to the transponder which specify the reply probability to the Mode S-Only All-Call interrogation UF=11 that contains the PR. A command to disregard any lockout state can also be given. The assigned codes are as follows: 0 = Reply with probability = 1. 1 = Reply with probability = 1/2. 2 = Reply with probability = 1/4. 3 = Reply with probability = 1/8. 4 = Reply with probability = 1/16. 5, 6, 7 = Do not reply. 8 = Disregard lockout, reply with probability = 1. 9 = Disregard lockout, reply with probability = 1/2. 10 = Disregard lockout, reply with probability = 1/4. 11 = Disregard lockout, reply with probability = 1/8. 12 = Disregard lockout, reply with probability = 1/16. 13, 14, 15 = Do not reply. NOTE: On receipt of a Mode S-Only All-Call containing a PR code other than 0 or 8, the transponder executes a random process and makes a reply decision for this interrogation in accordance with the commanded probability. Random occurrence of replies enables the interrogator to acquire closely spaced aircraft whose replies would otherwise synchronously garble each other.
RC		2	3,4	X		This 2-bit (3-4) uplink field designates the transmitted segment as initial, intermediate or final if coded 0, 1, 2 respectively. RC=3 is used to request Comm-D downlink action by the transponder. RC is part of the Comm-C interrogation, UF=24.
RI		4	14-17		X	This 4-bit (14-17) downlink field appears in the special surveillance reply formats DF=0, 16. This field reports the sensitivity level at which the TCAS unit is currently operating.

OVERVIEW OF FORMAT DEFINITIONS
Table E-3 Cont'd

FIELD	SUB FIELD	BITS NO.	BITS POSITION	FORMATS UP	FORMATS DOWN	CONTENT
RL		1	9	X		This 1-bit (9) uplink field in UF=0, 16 commands a reply in DF=0 if ZERO, and a reply in DF=16 ONE.
RR		5	9-13	X		This 5-bit (9-13) uplink field contains length and content of the reply requested by the interrogators. RR is part of the surveillance and Comm-A interrogations UF=4, 5, 20, 21.
						RR Code / Reply Length / MB Content 0-15 / Short / ----- 16 / Long / Air-Initiated Comm B 17 / Long / Extended Capability 18 / Long / Flight ID 19-31 / Long / Not assigned
						NOTE: If the first bit of the RR code is ONE, the last bits of the 5-bit RR code, if transformed into their decimal equivalent, designate the number (BDS1) of the requested source. BDS2 is assumed to be ZERO if not specified by DI=7 and RRS.
SD		16	17-32	X		This 16-bit (17-32) uplink field can contain control codes affecting transponder protocol and is part of surveillance and Comm-A interrogations UF=4, 5, 20, 21. The content of this field is specified by the DI field.
	IIS	4	17-20	X		The 4-bit (17-20) Interrogator Identifier Subfield contains the self-identification code of the interrogator which is numerically identical to the II code transmitted by the same interrogator in the Mode S-Only All-Call. IIS codes are assigned to interrogators and range from 0 through 15; IIS=0 is not a valid interrogator identifier for multisite purposes.
	LOS	1	17-20	X		The 1-bit (26) Lockout Subfield, if set to ONE, initiates a multisite All-Call lockout to Mode S-Only All-Calls (UF=11) from the Interrogator indicated in IIS of the same interrogation. If LOS is set to ZERO, no change in lockout state is commanded.

OVERVIEW OF FORMAT DEFINITIONS
Table E-3 Cont'd

FIELD	SUB FIELD	NO.	BITS POSITION	FORMATS UP	FORMATS DOWN	CONTENT
	MBS	2	21,22	X		The 2-bit (21,22) Multisite Comm-B Subfield has been assigned the following codes: 0 = No Comm-B action. 1 = Comm-B reservation. 2 = Comm-B closeout.
	MES	3	23-25	X		The 3-bit (23-25) Multisite ELM Subfield contains reservation and closeout commands for ELM as follows: 0 = No ELM action. 1 = Comm-C reservation. 2 = Comm-C closeout. 3 = Comm-D reservation. 4 = Comm-D closeout. 5 = Comm-C reservation and Comm-D closeout. 6 = Comm-C closeout and Comm-D reservation. 7 = Comm-C and Comm-D closeouts.
	RRS	4	21-24	X		
	RSS	2	27,28	X		The 2-bit (27-28) Reservation Status Subfield can request the transponder to report its reservation status in the UM field. The following codes have been assigned: 0 = No request. 1 = Report Comm-B reservation status in UM. 2 = Report Comm-C reservation status in UM. 3 = Report Comm-D reservation status in UM.
	TMS	4	29-32	X		Tactical Message Subfield, subfield in SD 4 bits, 29 through 32. 0 = No Action. 1 = Unlinked, Priority. 2 = Unlinked, Acknowledge. 3 = Unlinked, Priority, Acknowledge. 4 = Linked 1st Segment, Single ADS. 5 = Linked 1st Segment, Single ADS Priority. 6 = Linked 1st Segment, Single ADS Acknowledge. 7 = Linked 1st Segment, Single ADS Priority, Acknowledge. 8 = Linked 1st Segment, Multiple ADS. 9 = Linked 1st Segment, Multiple ADS, Priority. 10 = Linked 1st Segment, Multiple ADS, Acknowledge. 11 = Linked 1st Segment, Multiple ADS, Priority, Acknowledge. 12 = Second Segment. 13 = Third Segment. 13 = Third Segment. 14 = Final Segment. 15 = Not Assigned.
SL		3	9-11		X	This 3-bit (9-11) appears in special surveillance reply formats DF=0, 16. This field reports the sensitivity level at which the TCAS unit is currently operating.

OVERVIEW OF FORMAT DEFINITIONS
Table E-3 Cont'd

FIELD	SUB FIELD	NO.	BITS POSITION	FORMATS UP	FORMATS DOWN	CONTENT
						The codes are: 0 = No TCAS sensitivity level reported. 1 = TCAS is operating at sensitivity level 1. 2 = TCAS is operating at sensitivity level 2. 3 = TCAS is operating at sensitivity level 3. 4 = TCAS is operating at sensitivity level 4. 5 = TCAS is operating at sensitivity level 5. 6 = TCAS is operating at sensitivity level 6. 7 = TCAS is operating at sensitivity level 7. NOTE: The SL field has no meaning for aircraft that set RI=0,1, or 2 (no on-board capability to generate resolution advisories).
UF		5	1-5	X		The first field in all uplink formats is the transmission descriptor in all interrogations.
UM		6	14-19		X	This 6-bit (14-19) downlink field in DF=4, 5, 20, 21 contains transponder status readouts.
	IDS	2	18,19		X	The 2-bit (18-19) Identifier Designator Subfield reports the type of reservation made by the interrogator identified in IIS. Assigned coding is: 0 = No information available. 1 = Comm-B reservation active. 2 = Comm-C reservation active. 3 = Comm-D reservation active.
	IIS	4	14-17		X	The 4-bit (14-17) Interrogator Identifier Subfield reports the identity of the interrogator that has made a multisite reservation.
VS		1	6		X	This 1-bit (6) downlink field in DF=0, 16 indicates, when ZERO, that the aircraft is airborne and, when ONE, that the aircraft is on the ground.

OVERVIEW OF FORMAT DEFINITIONS
Table E-3 Cont'd

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APPENDIX F - SYSTEM ANOMALIES

The following list of observed discrepencies applies to the S-1403 Version 1.1 software. This list will be updated on a periodic basis through the use of Service Bulletins or Manual revisions. The explanations given are intended to prevent the user from operating the system in such a way that the results obtained would mislead them into assuming that a failing UUT might be assumed good or, conversely, that a properly operating UUT might be assumed bad.

1. System Problems

   A. General:

      1. When the ATC-1400A CW/NORM/OFF switch (7) is placed in OFF position during AP ERROR occurance, the error cannot be cleared without first returning to the NORM position, in fact, no messages are cleared when the switch is OFF.

      2. An interrmittent loss of output occurs as a result of an undetermined sequence of operations. A cause has not been determined at this time.

2. Function Problems

   A. ATC Function problems:

      1. The P3 pulse cannot be turned OFF with SLS ON (ATC-1400A SLS/ECHO switch (18)). Once P3 is turned OFF with SLS OFF, turning SLS ON again will leave P3 in the selected position.

      2. No DI/INTLCE ERROR message displayed on Control Menu 2.

   B. SEQ Function problems:

      1. In the Sequence Menu, data entry using the SLEW CONTROL (F) is unreliable. Always use the keyboard for data entry, in either octal or decimal data fields.

      2. Uplink data is sometimes changed when downlink data is received depending upon the cursor position. For best results, always position the cursor to the Sequence Number field when monitoring downlink data.

C. ACS and ACL Function problems:

1. The P3 pulse cannot be turned OFF with SLS ON (ATC-1400A SLS/ECHO Switch [18]). Once P3 is turned OFF with SLS OFF, turning SLS ON again will leave P3 in the selected position.

2. No DI/INTLCE ERROR message displayed on Control Menu 2.

D. DI Function problems:

1. Percent Reply values for ACS selections are incorrect. To obtain correct Percent Reply values for the ACS, use the ACS Function.

2. At a PRF of 750 in ATC;ATC configuration, the Percent Reply and Reply Delay fields may blank at random.

E. INTLCE Function problems:

1. No RATE ERROR message occurs when the ATC-1400A PRF thumbwheels (41) settings exceed 500. The S-1403 will not operate above this rate.

F. Burst Function problems:

1. The first time the BURST key is depressed after entering the BURST Function, reply data may not be displayed. For reliable results, always record the results from the second BURST when first enabling the function.

2. When bursting ACS and ACL, their scope triggers will occur 1.5 microseconds early.

3. The ATC-1400A DME RANGE, VELOCITY, and DISTANCE displays (43) indicate 000 instead of OFF.

G. REMOTE (GPIB) Operation problems:

1. When changing PPMG selection with CMENU2 displayed, the change is not reflected on the front panel althouggh the command is actually inplemented. Use the command "AX3=PPMG?" to observe the correct selection.

2. When the REMOTE mode is entered with errors occuring (error message displayed), the message will continue to be displayed on the front panel and also trigger the SRQ error interrupt (if enabled). Once the error condition has been cleared, the front panel will continue to display part of the first line of the current function.

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MODEL # _____ SERIAL # _____

MANUAL TYPE

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PUBLICATION DATE _____

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PAGE NO.	PARA. NO.	FIGURE NO.	TABLE NO.	COMMENTS

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IFR SYSTEMS, Inc.
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Wichita, Kansas 67215

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HIGHLIGHTS

This revision applies only to T-1401 TACAN Test Auxiliary's Serial Number 1515, 1551, 1552, 1553, 1600 and subsequent. Pages which have been revised are outlined below together with the highlights of each change. Please remove and/or insert affected pages noted below and enter Revision No. 1 dated June 30/89 to the Record of Revisions.

Unless noted otherwise, all changes are remove old pages(s) and insert similar numbered page(s).

Chapter/Section and Page No.	Description of Change
Front Matter	
Copyright Page	Reflects this revision.
List of Effective Pages (1 & 2)	Reflects this revision.
1 - Table of Contents (1 thru 3)	Reflects this revision.
1-2-1	
Page 3	Incorporates Service Bulletin No. 1.
1-2-2	
Pages 1, 3, 7 and 17	Revises callouts to reflect new configuration.
1-2-4	
Pages 3, 7, 9, 15, 19, 27, 31, 37, and 39	Revises callouts to reflect to new cofiguration.
Pages 1, 13, 25, 35, 45	Revises figures to correspond to new configuration.
Pages 47 through 86	Deleted.
1-2-5	
Page 1 though 19	New section for GPIB commands, revises command information.
1-2-6	
Pages 1	Revises error code information.
1-3-2	
Pages 1 thru 4	New Section for TACAN Test System Specifications.

2-2-1

Pages 13, 15, 21, 27 thru 31	Revises theory to reflect new configuration.
Page 23	Revises TACAN PC Board Block diagram for new configuration.

2-2-3

Pages 1 and 3	Revises troubleshooting table to reflect new configuration.

OPERATION/MAINTENANCE MANUAL

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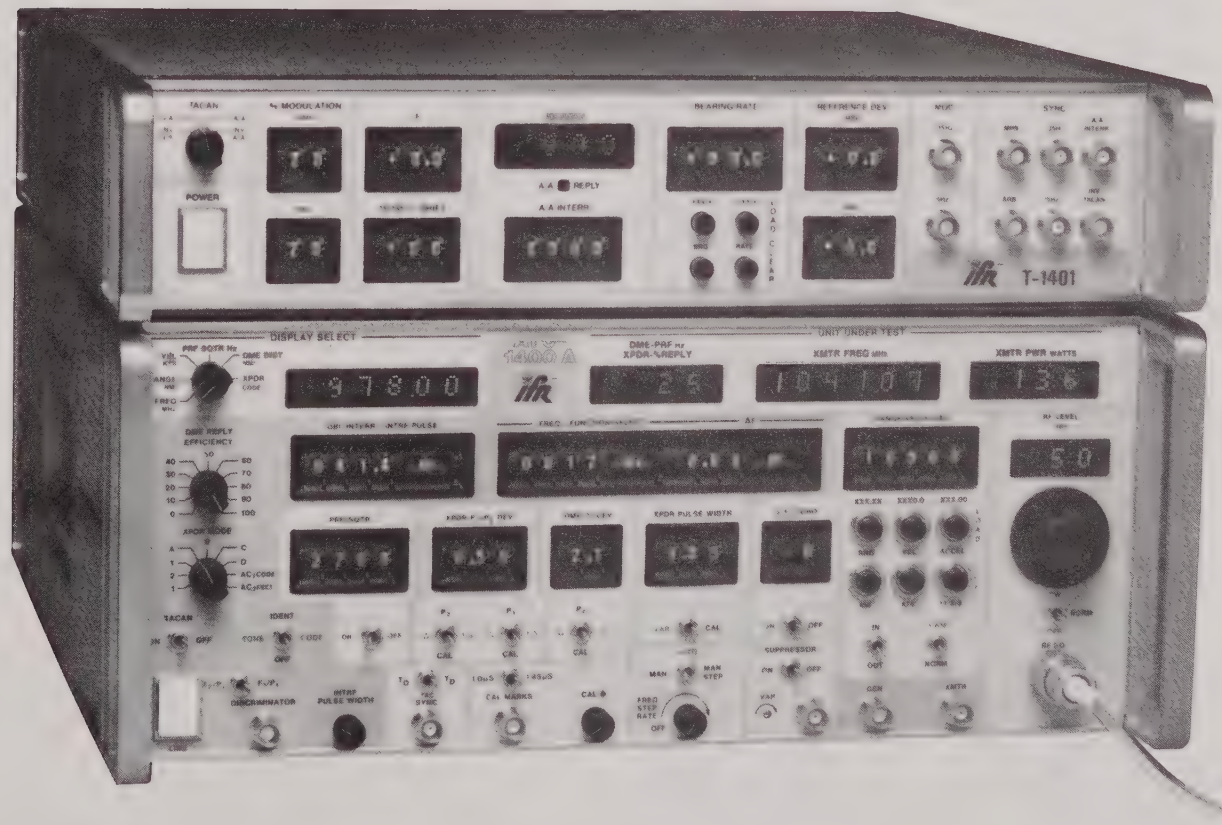
TACAN TEST SYSTEM



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TACAN TEST SYSTEM

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CHAPTER 1

TACAN TEST SYSTEM

OPERATION/MAINTENANCE MANUAL W/ILLUSTRATED PARTS LIST

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CHAPTER 1

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C. Power Requirements

The T-1401 power supply can operate over a voltage range of 105 to 120 or 210 to 250 VAC. No internal wiring changes are required prior to applying AC power to the test auxiliary. To select between 120 VAC and 220 VAC, ensure LINE Switch (35) setting on rear panel matches input line voltage. Instantaneous surge current at power up is less than 50 Amps. Input current varies to maintain constant power over the input voltage range (approximately 10 W), so it is important that the fuse selected has the correct rating for proper operation. The recommended fuse ratings are listed below:

INPUT VOLTAGE	F1 - AC IN FUSE	F2 - AC OUT VOLTAGE
105 to 120 VAC	3.0A 250V Fast Blo	1.0A 250V Fast Blo
220 to 250 VAC	3.0A 250V Fast Blo	0.5A 250V Fast Blo

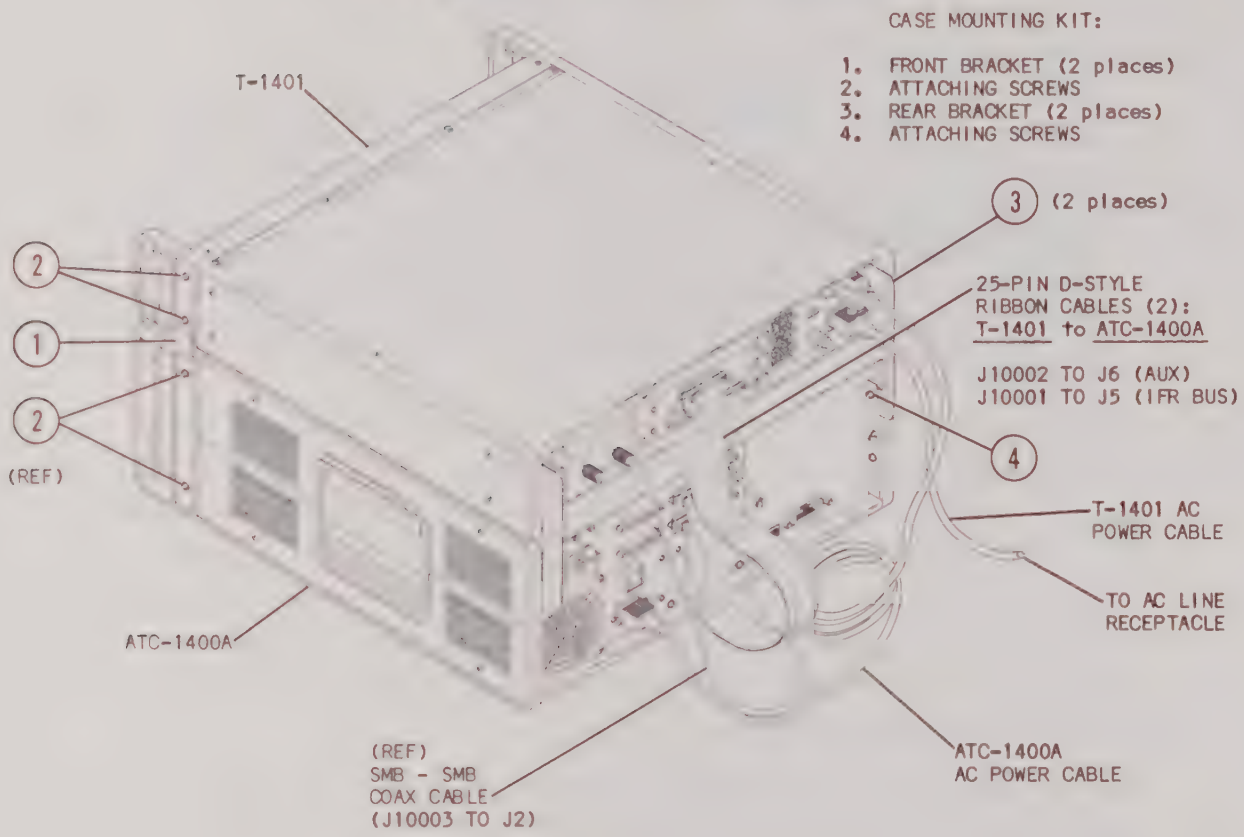
D. Installation Equipment

All electrical connections required to ready the instrument for operation can be easily made by hand, without using special tools.

E. Installation Procedure

The T-1401 and ATC-1400A are shipped in separate containers. To prepare the units for operation, proceed as follows:

STEP	PROCEDURE
1.	Remove both the T-1401 and ATC-1400A Test Sets from their respective containers.
2.	Place the T-1401 on top of the ATC-1400A.
3.	Connect the two 25-pin type D ribbon cables, SMB-to-SMB coax cable, two power cables and attaching hardware to test sets as shown in Figure 1.
4.	Calibrate the TACAN Test System per Section 2-2-2 Paragraph I, System Calibration. The System must be calibrated any time the T-1401 is replaced.



T-1401/ATC-1400A Interface
Figure 1

Conversion from bench-top to rack-mount installation is possible by ordering the following rack-mount kits:

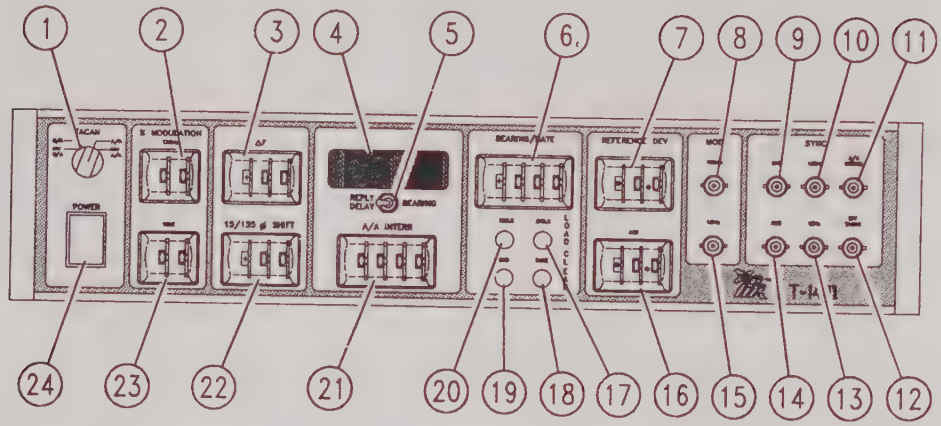
INSTRUMENT	IFR SYSTEMS PART NO.
ATC-1400A	7001-7636-800
T-1401	7001-6740-800

One kit per instrument is required for installation.

The T-1401, when interfaced with the ATC-1400A, can be installed in either a bench-top or rack-mount fashion. All IFR Systems, Inc., test sets are normally shipped from factory with plastic feet installed for a bench-top installation.

CAUTION: SPECIAL CARE MUST BE TAKEN TO AVOID RESTRICTION OF AIR FLOW TO INTAKE VENT, WHEN INSTALLING INSTRUMENT IN EITHER A BENCH-TOP OR RACK-MOUNT FASHION.

2. Description of Controls Item numbers in parentheses correspond to numb items called out in figures 3 and 4.



(1) TACAN CONTROL
(2) 135 Hz %MODULATION Thumbwheels
(3) ΔF Thumbwheels
(4) BEARING/REPLY DELAY Display
(5) DISPLAY SELECT Switch
(6) BEARING/RATE Thumbwheels
(7) REFERENCE DEV MRB Thumbwheels
(8) 135 Hz MOD Connector (J15003)
(9) MRB SYNC Connector (J15005)
(10) 135 Hz SYNC Connector (J15007)
(11) A/A INTERR SYNC Connect (J15009)
(12) INV TACAN SYNC Connecto (J15010)
(13) 15 Hz SYNC Connector (J15008)
(14) ARB SYNC Connector (J15
(15) 15 Hz MOD Connector (J15004)
(16) REFERENCE DEV ARB Thumbwheels
(17) LOAD RATE Pushbutton
(18) CLEAR RATE Pushbutton
(19) CLEAR BRG Pushbutton
(20) LOAD BRG Pushbutton

T-1401 Front Panel Controls and Indicators
Figure 3

A. T-1401 Front Panel

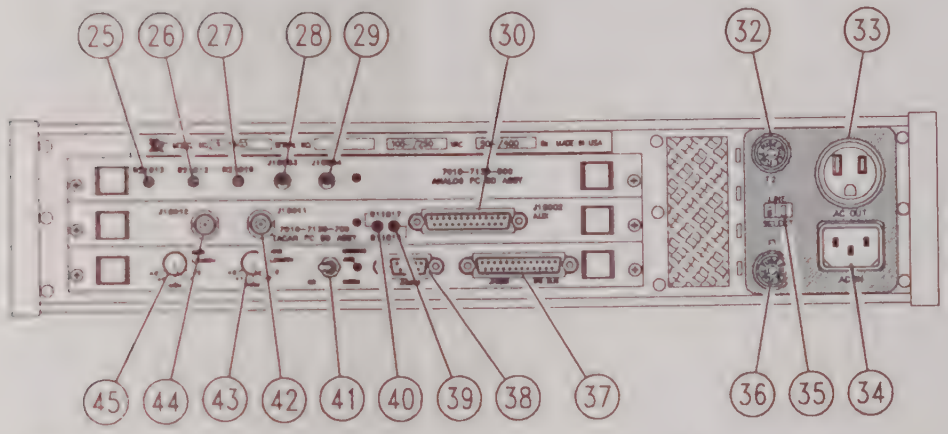
(1) TACAN Control

INV G/A Position - Sets the T-1401 to the INVERSE GROUND-TO-AIR Mode of operation.

G/A Position - Sets the T-1401 to the GROUND-TO-AIR Mode of operation.

A/A Position - Sets the T-1401 to the AIR-TO-AIR Mode of operation.

INV A/A Position - Sets the T-1401 to the INVERSE AIR-TO-AIR Mode of operation.



(21) A/A INTERR Thumbwheels
(22) 15/135 Ø SHIFT Thumbwheels
(23) 15 Hz % MODULATION Thumbwheels
(24) POWER Switch
(25) 135 Hz LEVEL Adjust (R21013)
(26) 15 Hz LEVEL Adjust (R21012)
(27) COMP MOD OFFSET Adjust (R21019)
(28) COMP MOD Connector (J10003)
(29) EXT Connector (J1004)
(30) AUX Connector (J10002)
(31) Deleted
(32) F2 Fuse
(33) AC OUT Connector
(34) AC IN Connector
(35) LINE SELECT Switch
(36) F1 Fuse
(37) IFR BUS Connector
(38) TEST Connector
(39) A/A Y Adjust (R11014)
(40) EQUALIZER Adjust (R11017)
(41) MISSING ARB Switch
(42) ENABLE INPUT Connector (J10011)
(43) ARB LENGTH Switch
(44) TRIGGER INPUT Connector
(45) MRB Switch

T-1401 Rear Panel Controls and Indicators
Figure 4

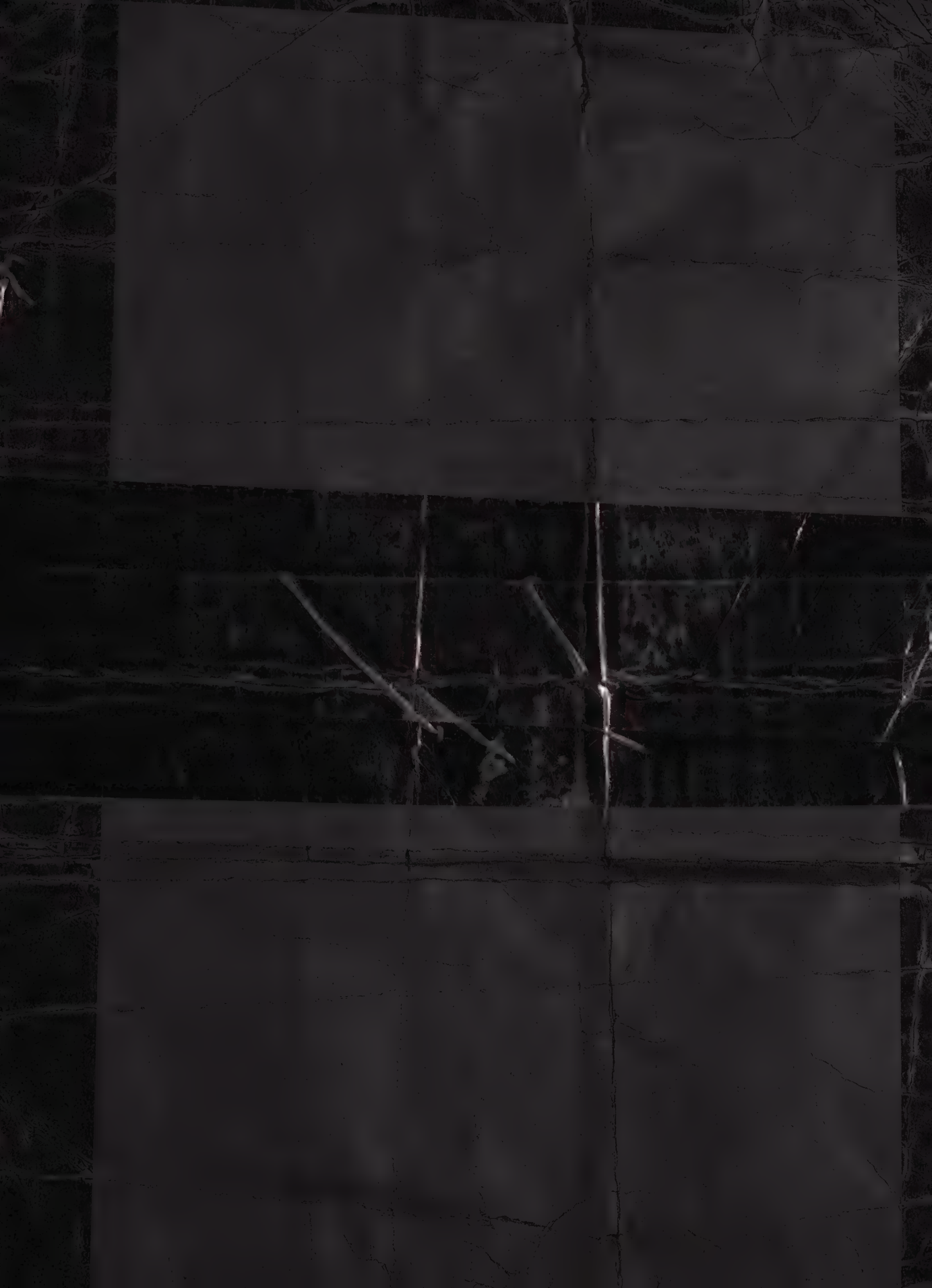
(2) 135 Hz % MODULATION Thumbwheels

Programs the percent modulation of the 135 Hz component of the TACAN modulation between 0% and 39% in 1% steps.

(3) ΔF Thumbwheels

Adjusts the TACAN timing reference oscillator from -3.9% to +3.9% of nominal value in 0.1% steps.

NOTE: The Delta F and Bearing Rate functions are mutually selective. Selecting a non-zero Delta F in the presence of a Bearing Rate will result in an Error code being displayed



on the BEARING/REPLY DELAY Display (4). Refer to Chapter 1, Section 2, Subject 5 for an explanation of the Error Codes.

(4) BEARING/REPLY DELAY Display

Normally displays the currently simulated bearing or reply delay output. If the T-1401 detects an error condition or the operator has selected an incompatible parameter value, an appropriate message will be displayed in place of the current bearing until the problem is resolved. Refer to Chapter 1, Section 2, Subject 5 for an explanation of the error messages.

(5) DISPLAY SELECT Switch

BEARING/REPLY DELAY Display (4) displays either bearing or reply delay based upon the position of this switch.

(6) BEARING/RATE Thumbwheels

Desired value of bearing and bearing rate is set in degrees for bearing and degrees per second for bearing rate.

SELECTION	RANGE	THUMBWHEEL SETTING
Bearing	000.0 to 359.9	0000 to 3599
Bearing Rate	-39.0 to +39.0	-39X to +39X

(7) REFERENCE DEV MRB Thumbwheels

G/A X Mode - Adjusts the deviation between the pairs of pulses that make up the Main Reference Burst. Adjustment is from -3.9 us to +3.9 us from the nominal value.

G/A Y Mode, A/A X Mode, A/A Y Mode - Adjusts the deviation between the single pulses that make up the Main Reference Burst. Adjustment is from -3.9 us to +3.9 us from the nominal value.

INV G/A and INV A/A Modes - Main Reference Burst not present.

OFF (DOT) Position -Disables the Main Reference Burst in all modes.

(8) 135 Hz MOD Connector (J15003)

A sample of the 135 Hz modulation signal is output at this connector. The level is adjusted from 0 V pp to 3.0 V pp as the 135 Hz % MODULATION Thumbwheels are set from 00% to 39%.

(9) MRB SYNC Connector (J15005)

A negative-going oscilloscope sync pulse, whose falling edge occurs immediately prior to the first pulse of the Main Reference Burst, is output at this connector.

(10) 135 Hz SYNC Connector (J15007)

A negative-going oscilloscope sync pulse, whose falling edge occurs at the positive-going zero crossing of the 135 Hz modulation signal, is output at this connector.

(11) A/A INTERR SYNC Connector (J15009)

A negative-going oscilloscope sync pulse, whose falling edge occurs immediately prior to the first pulse of an A/A Interrogation pulse pair, is output at this connector.

(12) INV TACAN SYNC Connector (J15010)

A positive-going North Reference Trigger pulse is output at this connector. The 15 Hz bearing in INV Mode is determined by the time delay between the rising edge of this pulse to the negative-going zero crossing of the 15 Hz modulating signal. This sync pulse is output only when INV G/A or INV A/A Modes have been selected on the TACAN Control (1).

(13) 15 Hz SYNC Connector (J15008)

A negative-going oscilloscope sync pulse, whose falling edge occurs at the positive-going zero crossing of the 15 Hz modulation signal, is output at this connector.

(14) ARB SYNC Connector (J15006)

A negative-going oscilloscope sync pulse whose falling edge occurs immediately prior to the first pulse of the Auxiliary Reference Burst, is output at this connector.

(15) 15 Hz MOD Connector (J15004)

A sample of the 15 Hz modulation signal is output at this connector. The level is adjusted from 0 V pp to 3.0 V pp as the 15 Hz % MODULATION Thumbwheels are set from 00% to 39%.

(31) Deleted

(32) F2 Fuse

Fuses the power to the AC OUT Connector. When the LINE SELECT Switch (35) is in the 115 VAC position, F2 should be 1.0 ampere fast blow. When the LINE SELECT Switch (35) is in the 230 VAC position, F2 should be a 0.50 ampere fast blow.

(33) AC OUT Connector

Convenience outlet used to power the ATC-1400A.

(34) AC IN Connector

Power receptacle for applying either 115 VAC or 230 VAC single phase power to the T-1401. LINE SELECT Switch (35) must be set to the correct position before applying power.

(35) LINE SELECT Switch

Selects the line voltage that will be applied to the T-1401.

(36) F1 Fuse

Fuses the power to the T-1401 and the AC OUT Connector. When the LINE SELECT Switch (35) is in either 230 VAC or 115 VAC position, F1 should be 3.0 amp fast blow.

(37) IFR BUS Connector (J10001)

Connects the T-1401 to the ATC-1400A so that information may be exchanged between the two units.

(38) TEST Connector (J10009)

RS-232 connector used for factory test.

(39) A/A REPLY DELAY Adjust (R11014)

Calibration adjustment for the A/A Reply Delay counters.

(40) EQUALIZER Adjust (R10017)

Calibration adjustment for the position of the Ident equalizing pulse pairs.

(41) MISSING ARB Switch

Deletes the first Auxiliary Reference Burst following the Main Reference Burst when set to the ON position.

(42) $\overline{\text{ENABLE}}$ INPUT Connector (J10011)

External input that gates off all other pulses including Ident and Reference bursts when active.

(43) ARB LENGTH Switch

Controls the number of pulse pairs in G/A X mode or single pulses in G/A Y Mode in the Auxiliary Reference Burst. One or two pulse pairs (single pulses) may be added or subtracted from the nominal value.

(44) $\overline{\text{TRIGGER}}$ INPUT Connector (J10010)

External input that triggers ATC-1400A Modulator whenever ENABLE INPUT Connector (J10011) is active.

(45) MRB LENGTH Switch

Controls the number of pulse pairs in G/A X or single pulses in G/A Y Mode, A/A X Mode, and A/A Y Mode in the main reference burst. One or two pulse pairs (single pulses) may be added from the nominal value.

4. GENERAL OPERATING PROCEDURES

This section contains operating instructions relating to both local control (front panel) operation operation of the TACAN Test System.

NOTE: The procedures contained within this section are general procedures, identifying the controls, connectors and indicators used for the individual test functions. Specific UUT Test Procedures have to be addressed in the UUT Manuals.

LOCAL CONTROL (Front Panel) OPERATION:

The T-1401 Test Auxiliary, when interfaced with the ATC-1400A Transponder/DME Test Set, has five distinct test functions of operation as listed below:

Paragraph	Test Function	Page No.
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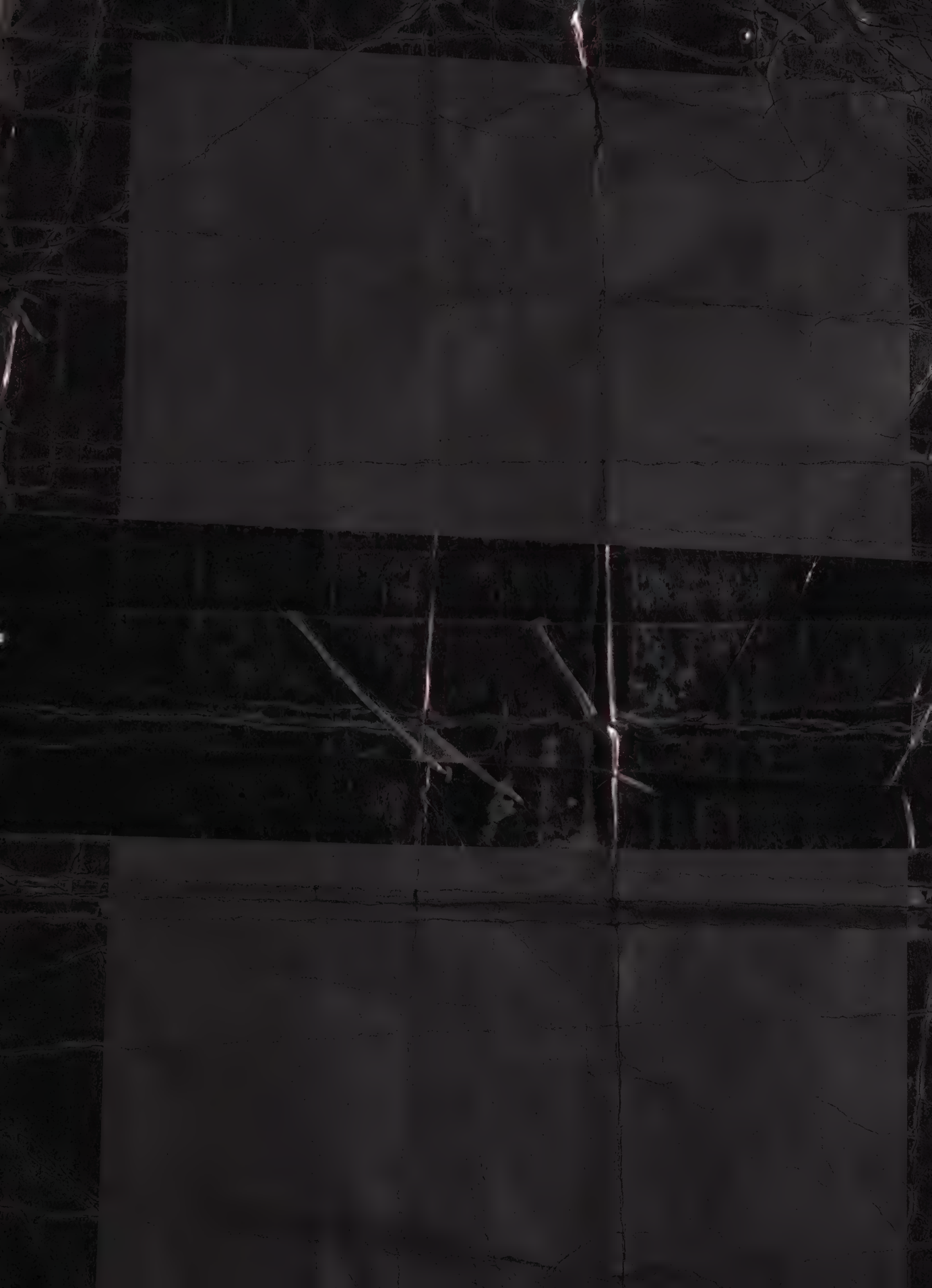
2-4-B	Inverse Ground-to-Air (G/A) Test Function	14
2-4-C	Air-to-Air (A/A) Test Function	26
2-4-D	Inverse Air-to-Air (A/A) Test Function	36

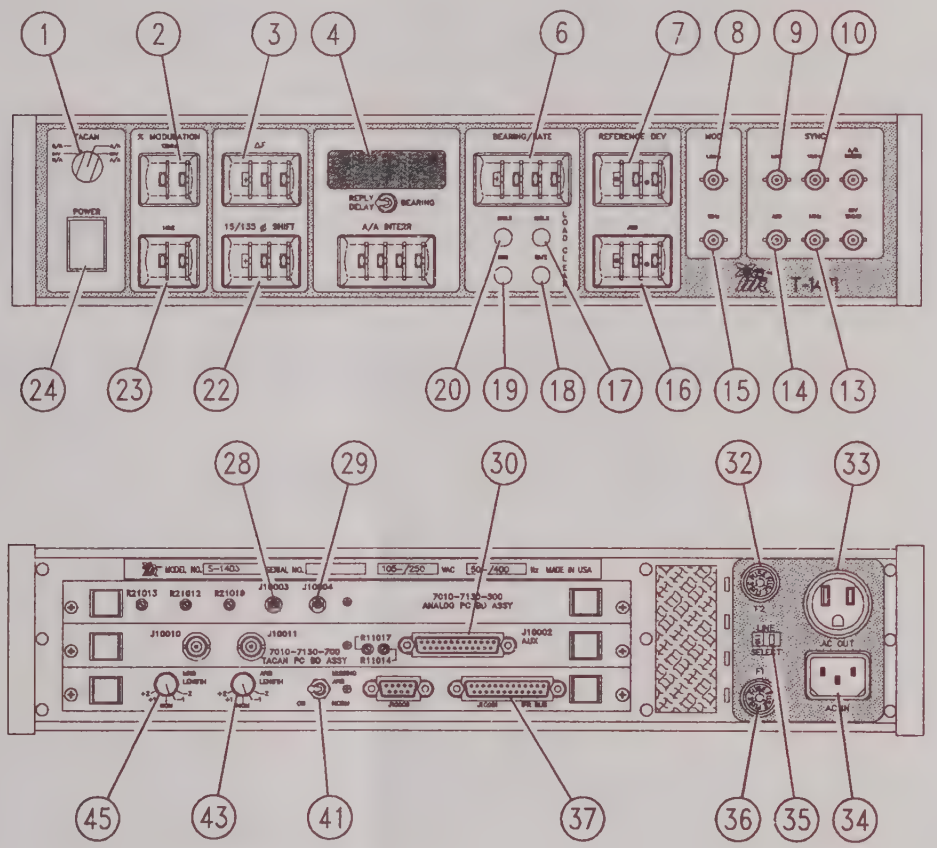
For the purpose of clarity and ease of understanding, the description of controls, connectors and indicators for only those controls (with nominal settings), as well as hook-up diagrams and timing charts will be shown for the test functions of operation discussed in that paragraph.

REMOTE CONTROL (GPIB) OPERATION

Remote communication with the TACAN Test System is provided by use of the General Purpose Interface Bus (GPIB), which conforms to IEEE Standard 488-1978. All communication with the TACAN Test System over the GPIB is implemented with ASCII enoded character strings. Section 1-2-5 contains the ASCII Commands used to control the T-1401 under GPIB operation.



A. Ground-to-Air (G/A) Test Function



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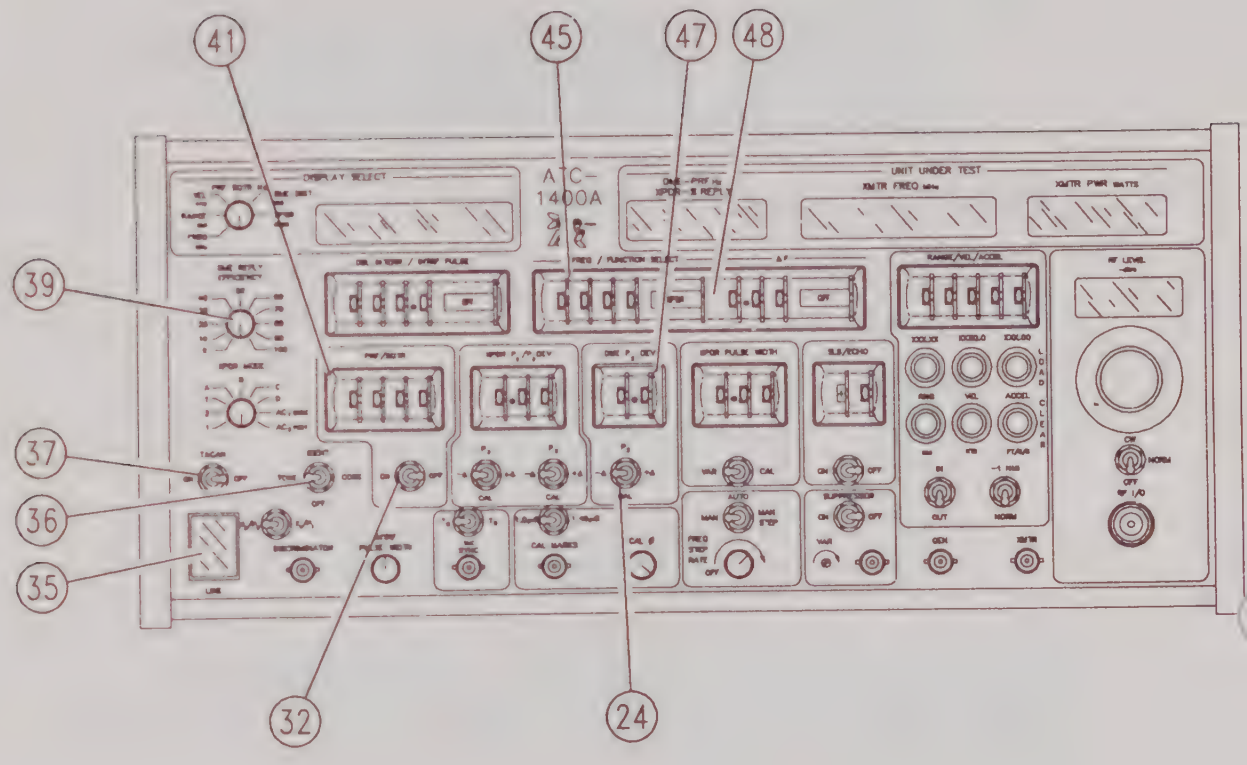
(2) 135 Hz %MODULATION Thumbwheels
(3) ΔF Thumbwheels
(4) BEARING/REPLY DELAY Display
(6) BEARING/RATE Thumbwheels
(7) REFERENCE DEV MRB Thumbwheels
(8) 135 Hz MOD Connector (J15003)
(9) MRB SYNC Connector (J15005)
(10) 135 Hz SYNC Connector (J15007)
(13) 15 Hz SYNC Connector (J15008)
(14) ARB SYNC Connector (J15006)
(15) 15 Hz MOD Connector (J15004)
(16) REFERENCE DEV ARB Thumbwheels
(17) LOAD RATE Pushbutton
(18) CLEAR RATE Pushbutton
(19) CLEAR BRG Pushbutton
(20) LOAD BRG Pushbutton
(22) 15/135 Ø SHIFT Thumbwheels
(23) 15 Hz % MODULATION Thumbwheels
(24) POWER Switch
(28) COMP MOD Connector (J10003)
(29) EXT Connector (J1004)
(30) AUX Connector (J10002
(32) F2 Fuse
(33) AC OUT Connector
(34) AC IN Connector
(35) LINE SELECT Switch
(36) F1 Fuse
(37) IFR BUS Connector
(41) MISSING ARB Switch
(43) ARB LENGTH Switch
(45) MRB LENGTH Switch



24 DME DEV P2/CAL Switch
32 PRF/SQTR ON/OFF Switch
35 LINE Switch
37 TACAN ON/OFF Switch
39 DME REPLY EFFICIENCY Control
41 PRF/SQTR Thumbwheels
45 FREQ/FUNCTION SELECT Thumbwheels
47 DME P2 DEV Thumbwheels
48 ΔF Thumbwheels

T-1401 and ATC-1400A Front and Rear Panel Controls, Connectors and Indicators used in G/A Test Operation

Figure 1

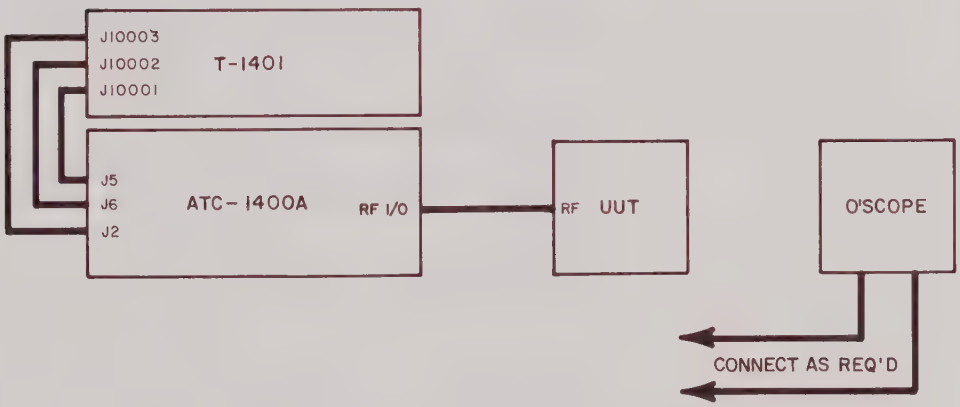
(1) T-1401 Description of Controls, Connectors, and Indicators Used in G/A Test Function

A complete description of the T-1401 Test Auxiliary Controls, Connectors and Indicators, used in conjunction with the ATC-1400A, while performing the G/A Test Function is described in this paragraph.

A complete description of the ATC-1400A Controls, Connectors and Indicators, used in conjunction with the T-1401, while performing the G/A Test Function is described in Paragraph 2-4-A(2).

In the G/A Test Mode, which is the primary mode of operation, the T-1401 provides the 15 Hz Modulation, 135 Hz Modulation, Main Reference Bursts and Auxiliary Reference Bursts. (Refer to Figure 17 for a description of the main and auxiliary reference groups).

NOTE: Beacon G/A Mode can effectively be selected by turning OFF the MRBs, ARBs, 15 Hz Modulation and 135 Hz modulation.



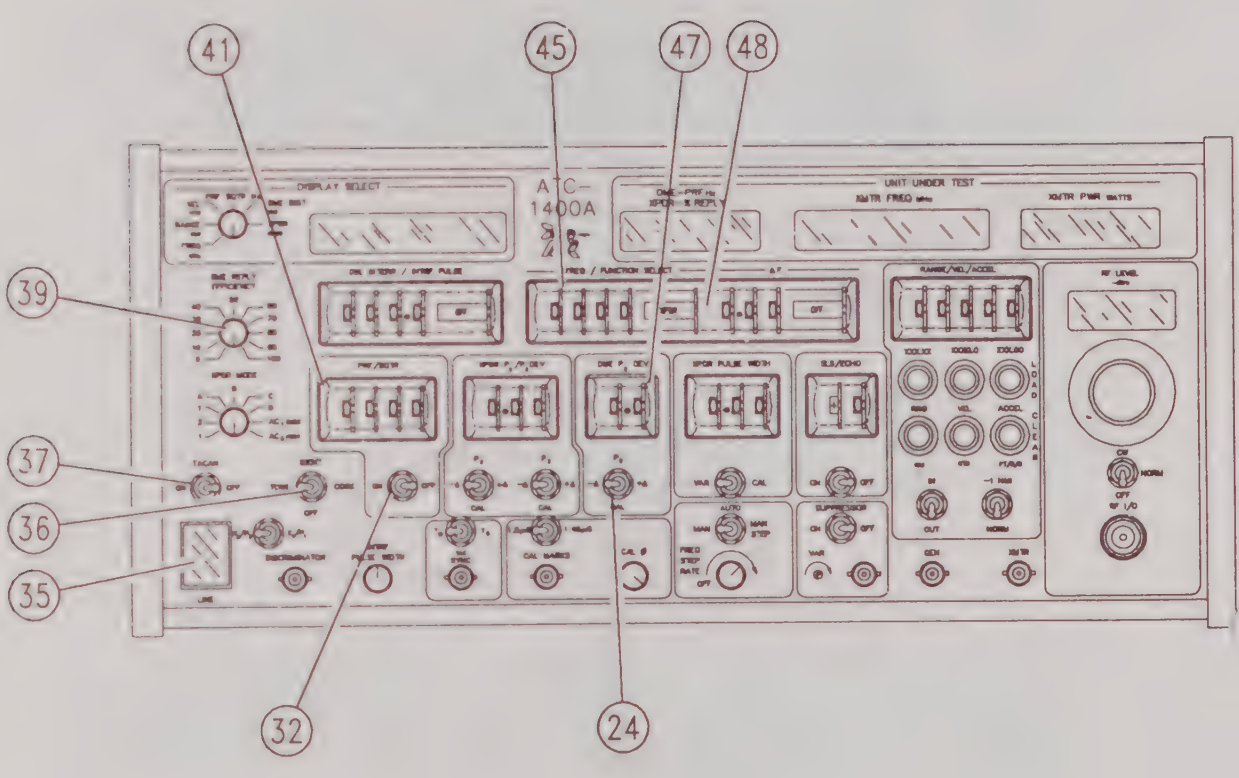
G/A Test Function Hook-up Diagram
Figure 2

ITEM	NAME	DESCRIPTION

1. TACAN Control

G/A Position - Sets the T-1401 to the GROUND-TO-AIR Mode of Operation.

NOMINAL SETTING - "G/A" Position



24	DME DEV P2/CAL Switch	41	PRF/SQTR Thumbwheels
32	PRF/SQTR ON/OFF Switch	45	FREQ/FUNCTION SELECT Thumbwheels
35	LINE Switch	47	DME P2 DEV Thumbwheels
37	TACAN ON/OFF Switch	48	ΔF Thumbwheels
39	DME REPLY EFFICIENCY Control		

T-1401 and ATC-1400A Front and Rear Panel Controls, Connectors and Indicators used in G/A Test Operation

Figure 1

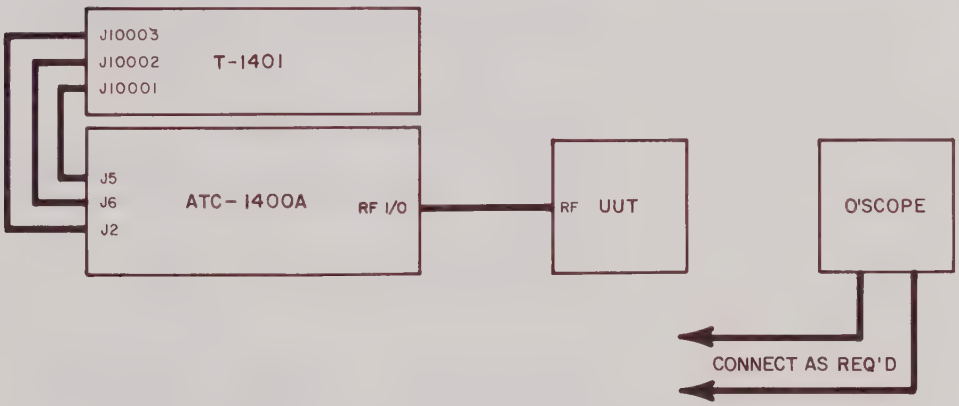
(1) T-1401 Description of Controls, Connectors, and Indicators Used in G/A Test Function

A complete description of the T-1401 Test Auxiliary Controls, Connectors and Indicators, used in conjunction with the ATC-1400A, while performing the G/A Test Function is described in this paragraph.

A complete description of the ATC-1400A Controls, Connectors and Indicators, used in conjunction with the T-1401, while performing the G/A Test Function is described in Paragraph 2-4-A(2).

In the G/A Test Mode, which is the primary mode of operation, the T-1401 provides the 15 Hz Modulation, 135 Hz Modulation, Main Reference Bursts and Auxiliary Reference Bursts. (Refer to Figure 17 for a description of the main and auxiliary reference groups).

NOTE: Beacon G/A Mode can effectively be selected by turning OFF the MRBs, ARBs, 15 Hz Modulation and 135 Hz modulation.



G/A Test Function Hook-up Diagram
Figure 2

ITEM	NAME	DESCRIPTION

1. TACAN Control

G/A Position - Sets the T-1401 to the GROUND-TO-AIR Mode of Operation.

NOMINAL SETTING - "G/A" Position

ITEM NAME DESCRIPTION

2. 135 Hz % Modulation Thumbwheels

Programs the percent modulation of the 135 Hz component of the TACAN modulation between 0% and 39% in 1% steps.

NOMINAL SETTING - "20%" Position

3. DELTA F Thumbwheels

Adjusts the TACAN timing reference oscillator from -3.9% to +3.9% of nominal value in 0.1% steps.

NOMINAL SETTING - "+0.0" Position

4. BEARING Display

Normally displays the currently simulated bearing or reply delay output. If the T-1401 detects an error condition or the operator has selected an incompatable parameter value, an appropriate message will be displayed in place of the current bearing until the problem is resolved. Refer to Section 1-2-5 for an explanation of the error messages.

6. BEARING/RATE Thumbwheels

Desired value of bearing and bearing rate is set in degrees for bearing and degrees per second for bearing rate.

SELECTION	Range	THUMBWHEEL SETTING
Bearing	000.0 to 359.9	0000 to 3599
Bearing Rate	-39.0 to +39.0	-39X to +39X

7. REFERENCE DEV MRB Thumbwheels

G/A X Mode - Adjusts the deviation between the pairs of pulses that make up the Main Reference Burst. Adjustment is from -3.9 μs to +3.9 μs from the nominal value.

NOMINAL SETTING - "+0.0" Position

ITEM NAME DESCRIPTION

NOMINAL SETTING: "00" Position

23. 15 Hz % MODULATION Thumbwheels

Programs the percent modulation of the 15 Hz component of TACAN modulation between 0% and 39% in 1% steps.

NOMINAL SETTING: "20%" Position

24. POWER Switch

Applies external AC power to the T-1401 and to the ATC-1400A when it is connected to the AC OUT (33) convenience outlet on the rear of the T-1401.

28. COMP MOD Connector

15/135 Hz Composite modulation output from the T-1401 to the ATC-1400A.

29. EXT F Connector

Input for external frequency source for the TACAN signal timing reference.

NOTE: Input is enabled through the IFR BUS.

30. AUXILIARY Connector

Connects the T-1401 to the ATC-1400A to provide discrete signal interconnect.

32. F2 Fuse

Fuses the power to the AC OUT connector. When the LINE SELECT Switch (35) is in the 115 VAC position, F2 should be 1.0 amp fast blow. When the LINE SELECT Switch (35) is in the 230 VAC position, F2 should be a 0.5 amp fast blow.

33. AC OUT Connector

Convenience outlet normally used to power the ATC-1400A.

ITEM	NAME	DESCRIPTION

34. AC IN Connector

Power receptacle for applying either 115 VAC or 230 VAC single phase power to the T-1401. LINE SELECT Switch (35) must be set to the correct position before applying power.

35. LINE SELECT Switch

Selects the line voltage that will be applied to the T-1401.

36. F1 Fuse

Fuses the power to the T-1401 and the AC OUT Connector. When the LINE SELECT Switch (35) is in either the 230 VAC or 115 VAC position, F1 should be a 3.0 amp fast blow.

37. IFR BUS Connector

Connects the T-1401 to the ATC-1400A so that information may be exchanged between the two units.

41. MISSING ARB Switch

Deletes the first Auxiliary Reference Burst following the Main Reference Burst when set to the ON position.

NOMINAL SETTING - "OFF" Position

43. ARB LENGTH Switch

Controls the number of pulse pairs in G/A X mode or single pulses in G/A Y mode in the Auxiliary Reference Burst. One or two pulse pairs (single pulses) may be added or subtracted from the nominal value.

NOMINAL SETTING - "NOM" Position

ITEM NAME DESCRIPTION

45. MRB LENGTH Switch

Controls the number of pulse pairs in G/A X mode or single pulses in G/A Y mode, A/A X mode, and A/A Y mode in the Main Reference Burst. One or two pulse pairs (single pulses) may be added or subtracted from the nominal value.

NOMINAL SETTING - "NOM" Position

(2) ATC-1400A Description of Controls, Connectors and Indicators Used in G/A Test Function

24. DME DEV P_2/CAL Switch (DME)

"CAL" Position - P_2 pulse remains in nominal position. DME DEV P_2/CAL Thumbwheels (47) have no effect on deviating P_2 pulses.

NOMINAL SETTING - "CAL" Position

32. PRF/SQTR ON/OFF Switch

Two position toggle switch which when placed in OFF position, will inhibit squitter.

NOMINAL SETTING - "ON" Position

35. LINE Switch

Applies external AC Power to ATC-1400A Test Set.

36. IDENT TONE/OFF/CODE Switch (DME)

"CODE" Position - Modulates 1350 Hz tone with Morse code "IFR". Repetition rate is approximately every 37 seconds.

NOMINAL SETTING - "CODE" Position

37. TACAN ON/OFF Switch (DME)

"ON" Position - Simulates a TACAN ground station. En the T-1401.

NOMINAL SETTING - "ON" Position

ITEM NAME DESCRIPTION

39. DME REPLY EFFICIENCY Control (DME)

Range replies are produced only in response to a valid interrogation (i.e., P_1 to P_2 spacing is 12 µS for G/A X Mode and 36 µS for G/A Y Mode). Selection of any position of this control selects ATC-1400A reply efficiency rate (i.e., "50" position equals 50% reply rate and "100" position equals 100% reply rate).

NOMINAL SETTING: "70%" Position

41. PRF/SQTR Thumbwheels

DME Function - Select the mean squitter rate in Hz. ATC-1400A Squitter is defined as nominal level pulse pairs of random spacing generated at a mean squitter rate, as selected by thumbwheel setting.

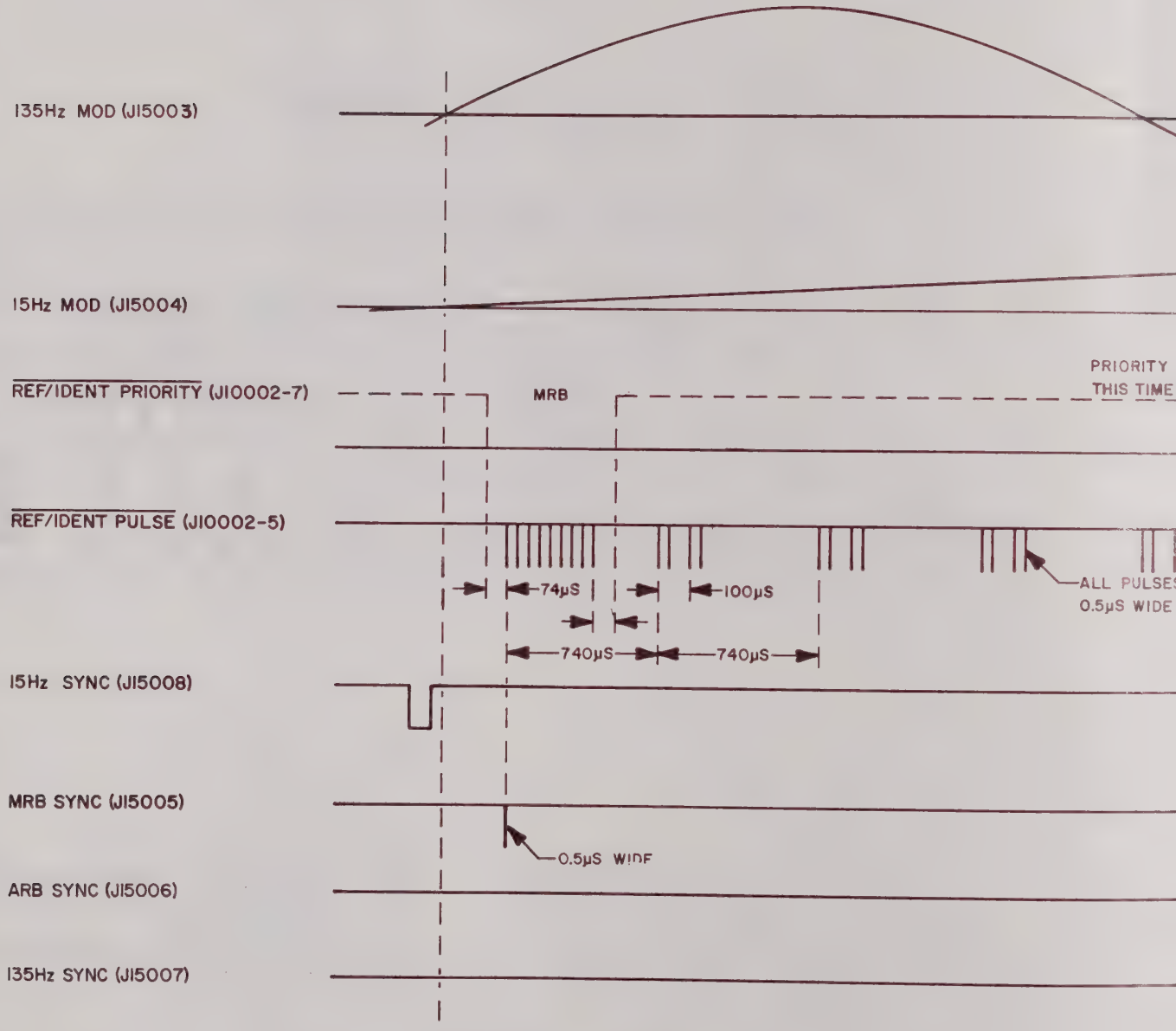
NOMINAL SETTING: "2700 Hz" Position

45. FREQ/FUNCTION SELECT Thumbwheels

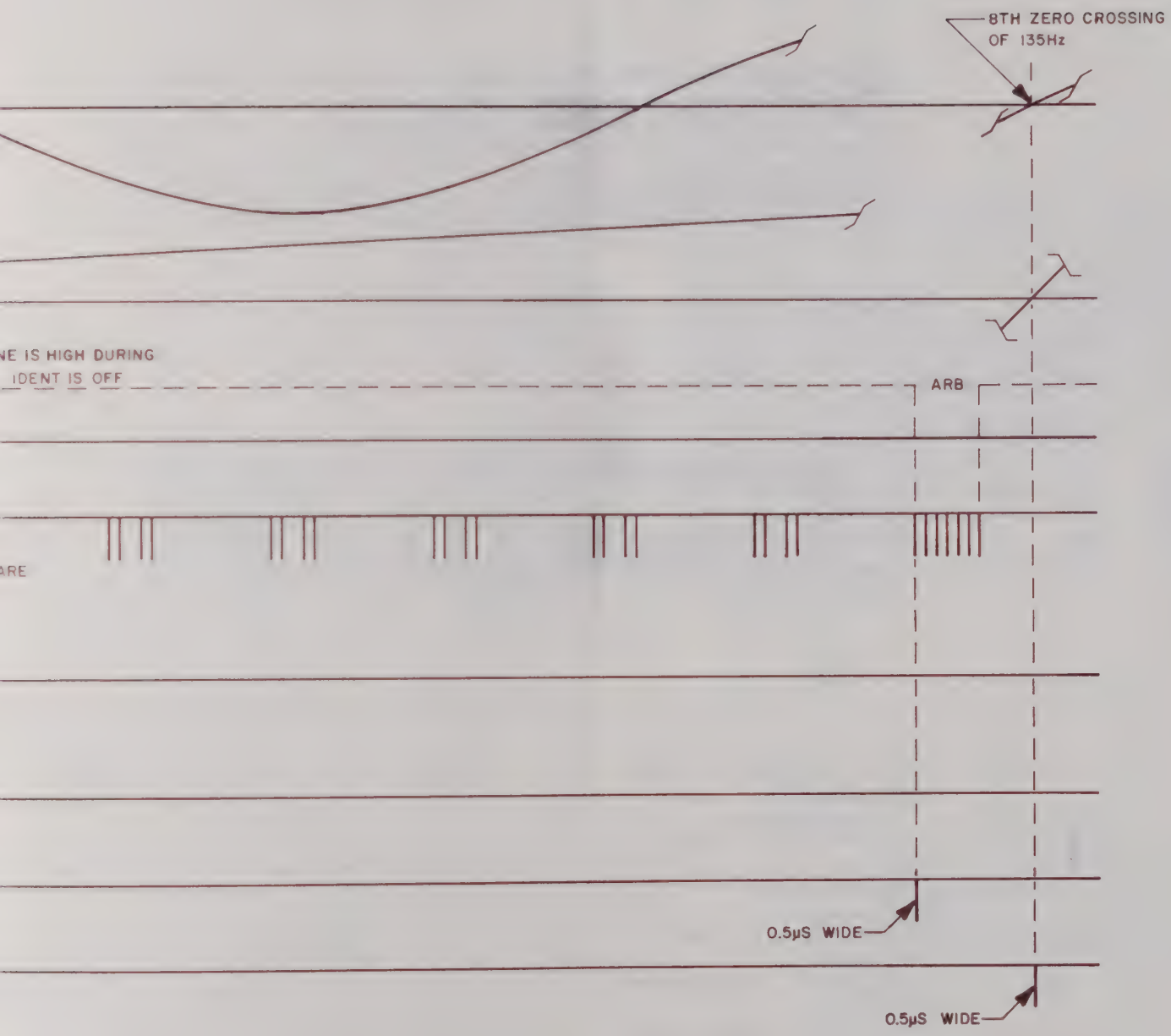
Select function of operation and frequency of test set. Numbers in MHz relate to function viewed in the window. Function and frequency is listed as follows:

WINDOW DISPLAY	OPERATION FUNCTION	RANGE	THUMBWHEEL RANGE
XPDR	TRANSPONDER	962 MHz-1213 MHz	0962-1213
TAC Y	DME-Y Ch	Channel 1-Channel 126	0001-0126
TAC X	DME-X Ch	Channel 1-Channel 126	0001-0126
5 VOR PAIR	DME-Y Ch	108.05 MHz-117.95 MHz	1080-1179
0 VOR PAIR	DME-X Ch	108.00 MHz-117.90 MHz	1080-1179
MHz Y	DME-Y Ch	962 MHz-1213 MHz	0962-1213
MHz X	DME-X Ch	962 MHz-1213 MHz	0962-1213

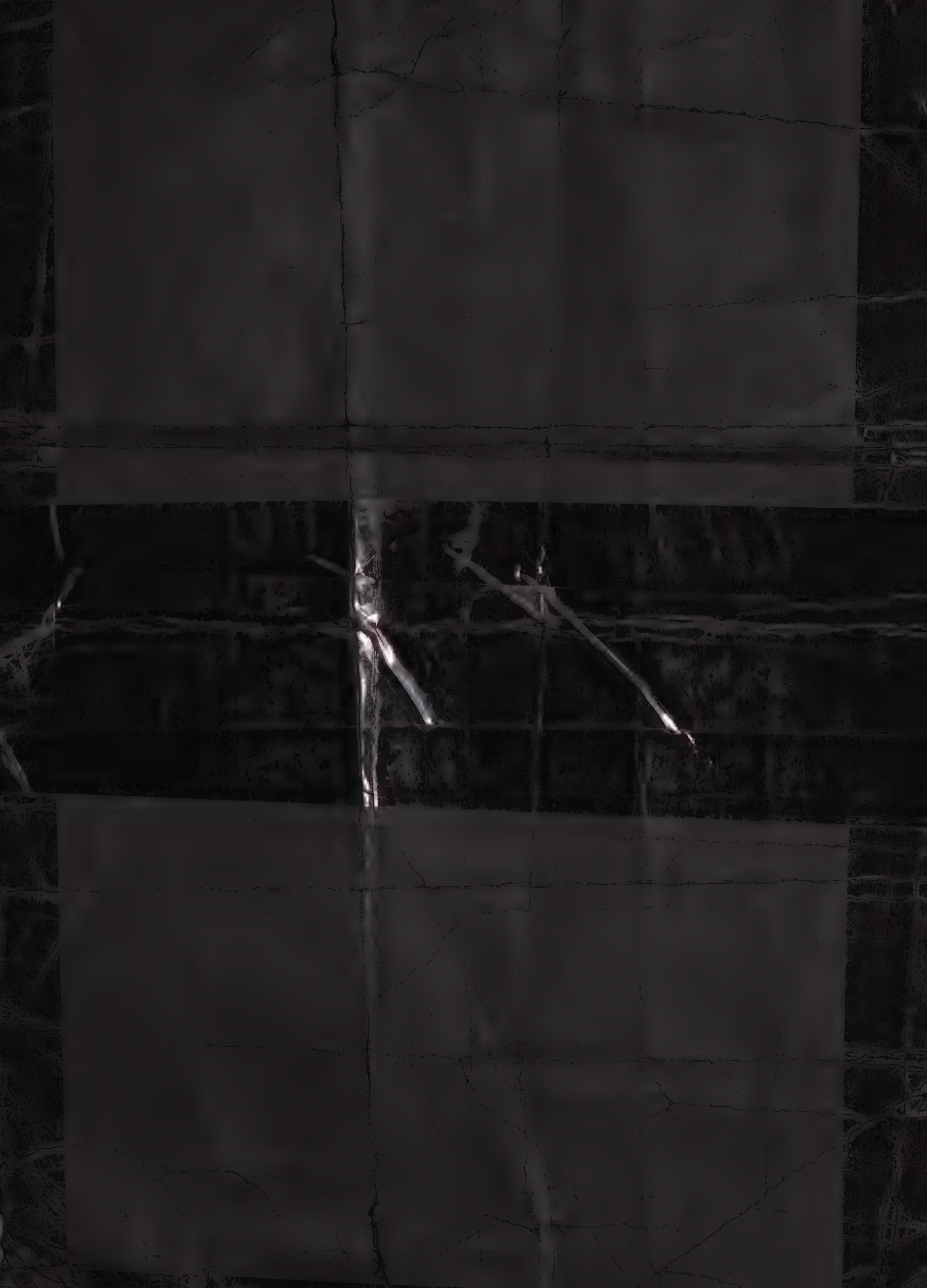
NOTE: Selection of XPDR function disables the TACAN Test Auxiliary and "OFF" is displayed in the T-1401 BEARING Display (4).

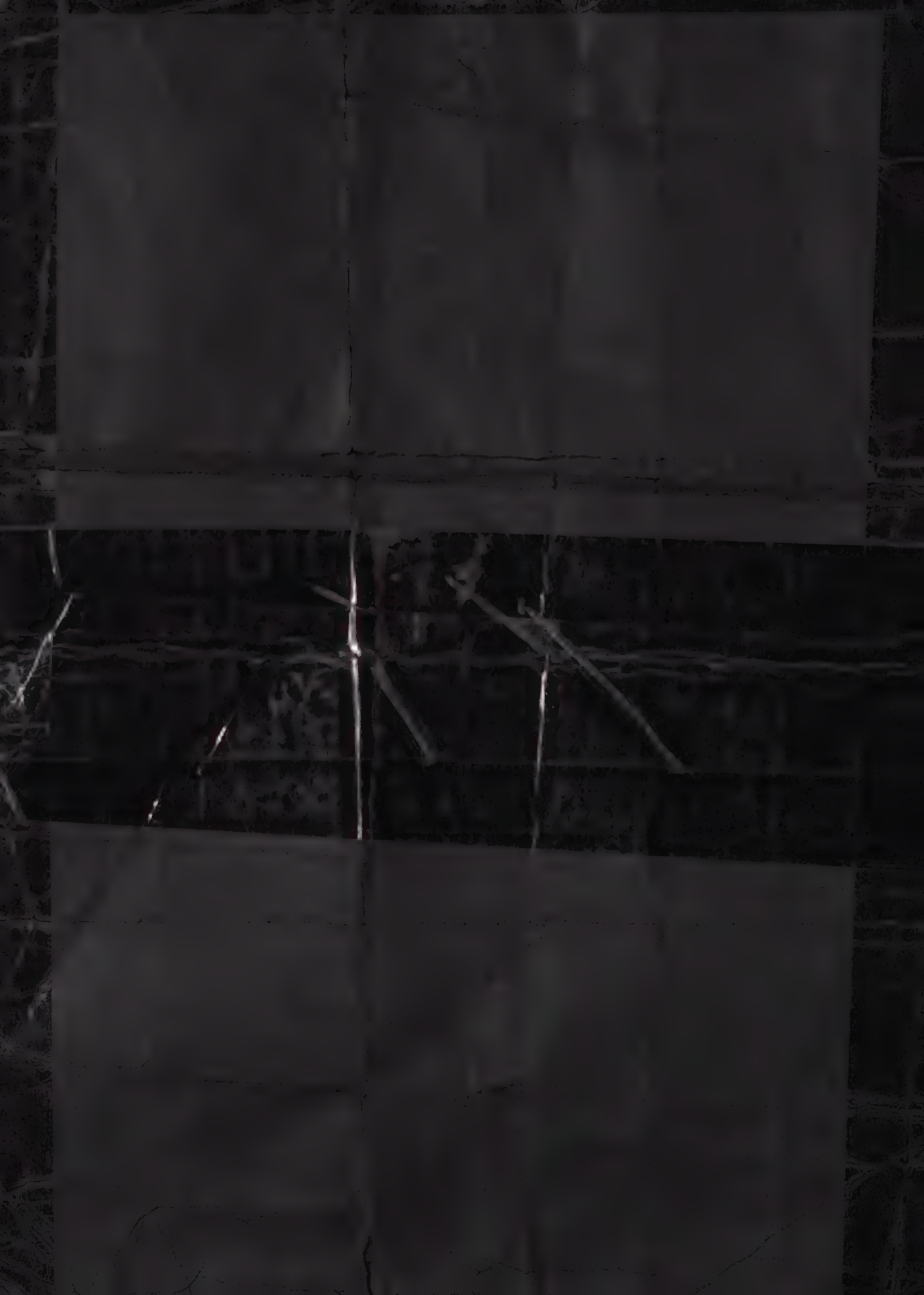


NOTE: ALL TIMING IS REFERENCED TO FALLING EDGE OF PULSES.

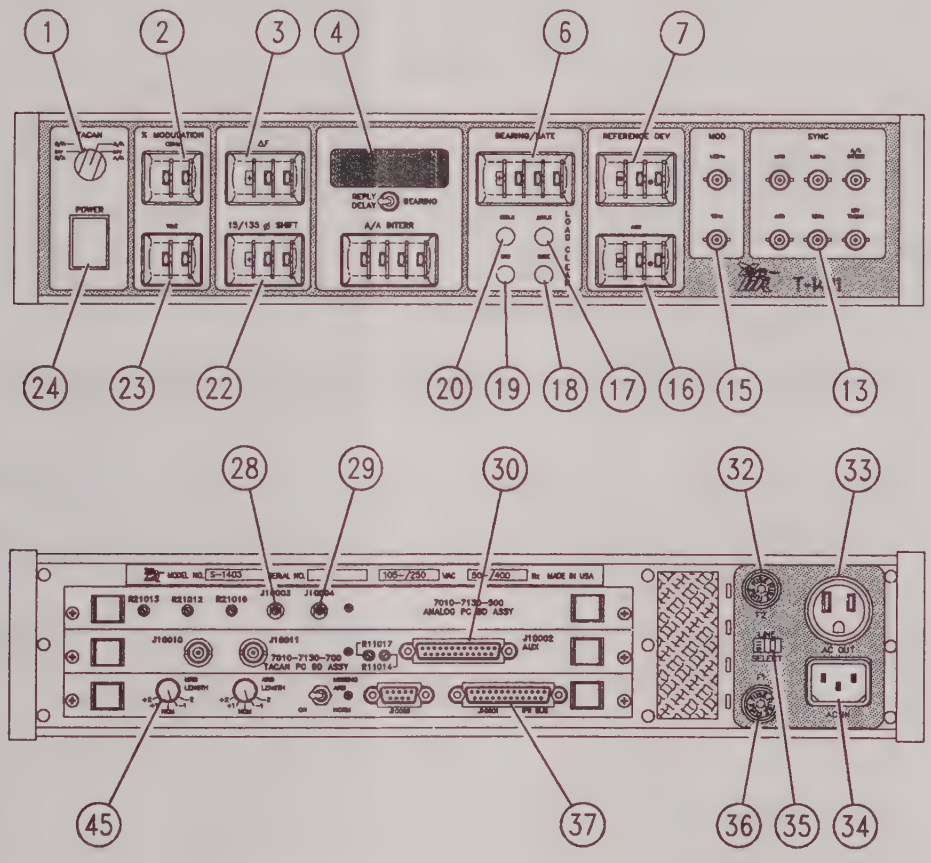


Ground-To-Air Test Function
Timing Chart
Figure 3

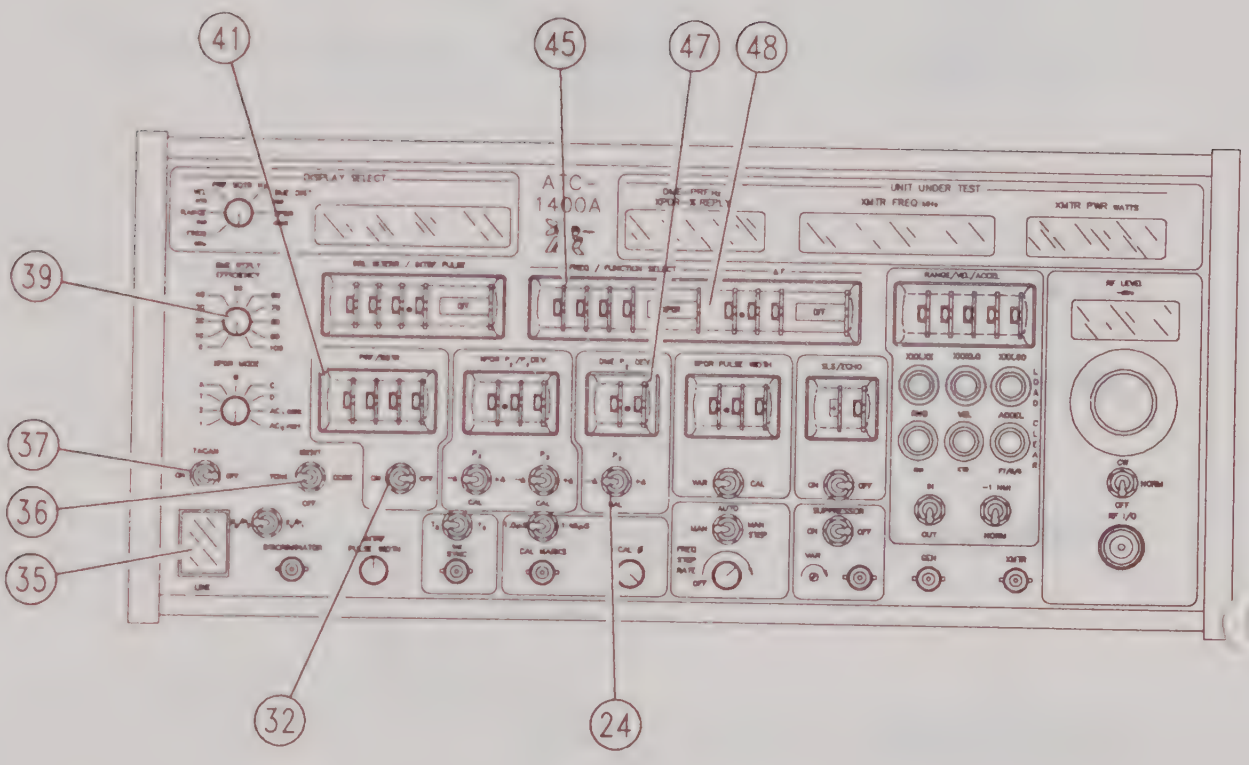




B. Inverse Ground-To-Air (G/A) Test Function



(1) TACAN CONTROL
(2) 135 Hz %MODULATION Thumbwheels
(3) ΔF Thumbwheels
(4) BEARING/REPLY DELAY Display
(6) BEARING/RATE Thumbwheels
(7) REFERENCE DEV MRB Thumbwheels
(13) 15 Hz SYNC Connector (J15008)
(15) 15 Hz MOD Connector (J15004)
(16) REFERENCE DEV ARB Thumbwheels
(17) LOAD RATE Pushbutton
(18) CLEAR RATE Pushbutton
(19) CLEAR BRG Pushbutton
(20) LOAD BRG Pushbutton
(22) 15/135 Ø SHIFT Thumbwheels
(23) 15 Hz % MODULATION Thumbwheels
(24) POWER Switch
(28) COMP MOD Connector (J10003)
(29) EXT Connector (J1004)
(30) AUX Connector (J10002)
(32) F2 Fuse
(33) AC OUT Connector
(34) AC IN Connector
(35) LINE SELECT Switch
(36) F1 Fuse
(37) IFR BUS Connector
(45) MRB LENGTH Switch



24 DME DEV P2/CAL Switch
32 PRF/SQTR ON/OFF Switch
35 LINE Switch
37 TACAN ON/OFF Switch
39 DME REPLY EFFICIENCY Control
41 PRF/SQTR Thumbwheels
45 FREQ/FUNCTION SELECT Thumbwheels
47 DME P2 DEV Thumbwheels
48 ΔF Thumbwheels

T-1401 and ATC-1400A Front and Rear Panel Controls, Connectors and Indicators used in Inverse G/A Test Operation

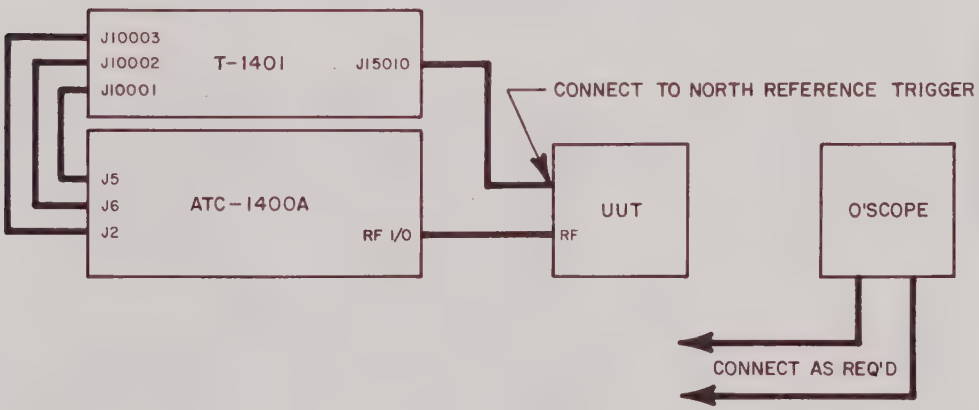
Figure 4

(1) T-1401 Description Of Controls, Connectors, and Indicators Used In Inverse G/A Test Function

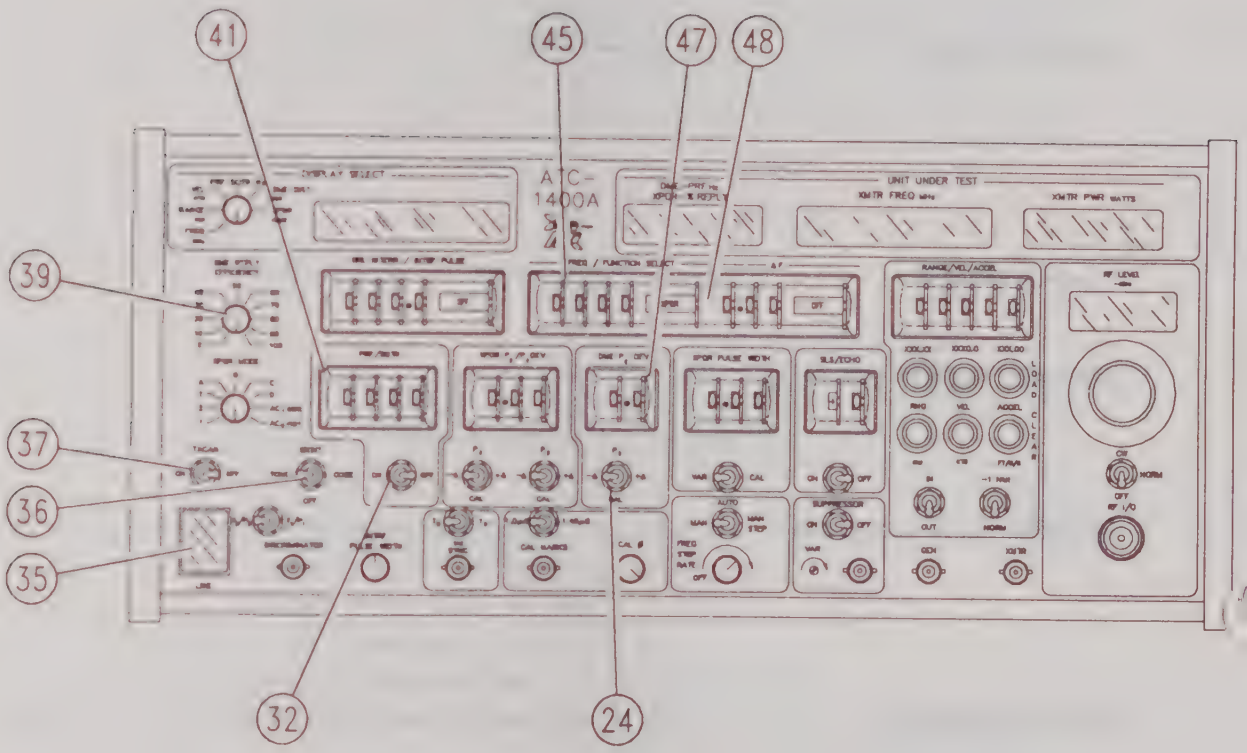
A complete description of the T-1401 Test Auxiliary Controls, Connectors and Indicators, used in conjunction with the ATC-1400A, while performing the INVERSE G/A Test Function is described in this paragraph.

A complete description of the ATC-1400A Controls, Connectors and Indicators, used in conjunction with the T-1401, while performing the INVERSE G/A Test Function is described in Paragraph 2-4-B(2).

In the Inverse G/A Test Mode, the Airborne TACAN Beacon is equipped with a rotating antenna to provide both bearing and distance information. The DME reply information (Squitter, Ident. and Range Replies) is modulated with a 15 Hz Envelope. An inverse SYNC Signal is a 15 Hz envelope. An inverse SYNC signal is generated coincident with the negative going zero crossing of the 15 Hz modulated signal to simulate the antenna at zero degrees bearing. ARB and MRB pulses are inhibited.



INVERSE G/A Test Function Hook-up Diagram
Figure 5



24	DME DEV P2/CAL Switch	41	PRF/SQTR Thumbwheels
32	PRF/SQTR ON/OFF Switch	45	FREQ/FUNCTION SELECT Thumbwheels
35	LINE Switch	47	DME P2 DEV Thumbwheels
37	TACAN ON/OFF Switch	48	ΔF Thumbwheels
39	DME REPLY EFFICIENCY Control		

T-1401 and ATC-1400A Front and Rear Panel Controls, Connectors and Indicators used in Inverse G/A Test Operation

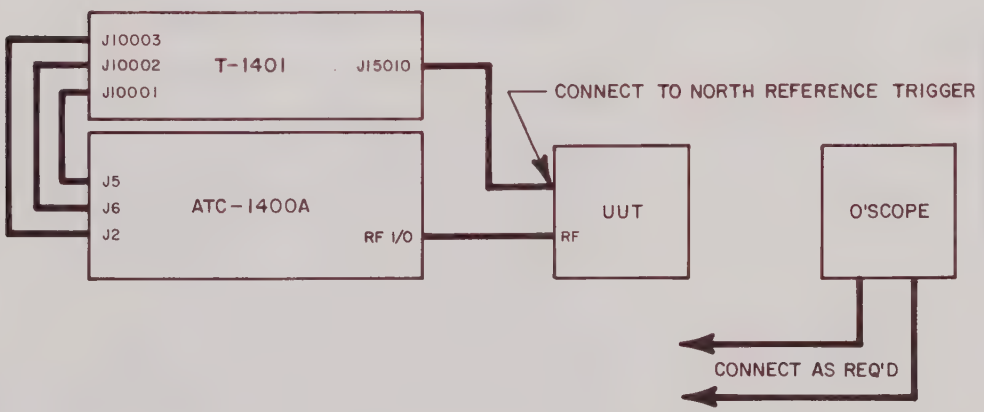
Figure 4

(1) T-1401 Description Of Controls, Connectors, and Indicators Used In Inverse G/A Test Function

A complete description of the T-1401 Test Auxiliary Controls, Connectors and Indicators, used in conjunction with the ATC-1400A, while performing the INVERSE G/A Test Function is described in this paragraph.

A complete description of the ATC-1400A Controls, Connectors and Indicators, used in conjunction with the T-1401, while performing the INVERSE G/A Test Function is described in Paragraph 2-4-B(2).

In the Inverse G/A Test Mode, the Airborne TACAN Beacon is equipped with a rotating antenna to provide both bearing and distance information. The DME reply information (Squitter, Ident. and Range Replies) is modulated with a 15 Hz Envelope. An inverse SYNC Signal is a 15 Hz envelope. An inverse SYNC signal is generated coincident with the negative going zero crossing of the 15 Hz modulated signal to simulate the antenna at zero degrees bearing. ARB and MRB pulses are inhibited.



INVERSE G/A Test Function Hook-up Diagram
Figure 5

ITEM NAME DESCRIPTION

1. TACAN Control

INV G/A
Position - Sets the T-1401 to the INVERSE GROUND-TO-AIR Mode of Operation.

NOMINAL SETTING - "INV G/A" Position

2. 135 Hz % Modulation Thumbwheels

Programs the percent modulation of the 135 Hz component of the TACAN modulation between 0% and 39% in 1% steps.

NOMINAL SETTING - "00%" Position

3. DELTA F Thumbwheels

Adjusts the TACAN timing reference oscillator from -3.9% to +3.9% of nominal value in 0.1% steps.

NOMINAL SETTING - "0.0" Position

4. BEARING/REPLY DELAY Display

Normally displays the currently simulated bearing or reply delay output. If the T-1401 detects an error condition or the operator has selected an incompatable parameter value, an appropriate message will be displayed in place of the current bearing until the problem is resolved. Refer to Section 1-2-5 for an explanation of the error messages.

6. BEARING/RATE Thumbwheels

Desired value of bearing and bearing rate is set in degrees for bearing and degrees per second for bearing rate.

SELECTION	RANGE	THUMBWHEEL SETTING
Bearing	000.0 to 359.9	0000 to 3599
Bearing Rate	-39.0 to +39.0	-39X to +39X

ITEM	NAME	DESCRIPTION

29. EXT F Connector

Input for external frequency source for the TACAN signal timing reference.

NOTE: Input is enabled through the IFR BUS.

30. AUXILIARY Connector

Connects the T-1401 to the ATC-1400A to provide discrete signal interconnect.

32. F2 Fuse

Fuses the power to the AC OUT connector. When the LINE SELECT Switch (35) is in the 115 VAC position, F2 should be 1.0 amp fast blow. When the LINE SELECT Switch (35) is in the 230 VAC position, F2 should be a 0.5 amp fast blow.

33. AC OUT Connector

Convenience outlet normally used to power the ATC-1400A.

34. AC IN Connector

Power receptacle for applying either 115 VAC or 230 VAC single phase power to the T-1401. LINE SELECT Switch (35) must be set to the correct position before applying power.

35. LINE SELECT Switch

Selects the line voltage that will be applied to the T-1401.

36. F1 Fuse

Fuses the power to the T-1401 and the AC OUT Connector. When the LINE SELECT Switch (35) is in either the 115 VAC or 230 VAC position, F1 should be a 3.0 amp fast blow.

ITEM	NAME	DESCRIPTION

37. IFR BUS Connector

Connects the T-1401 to the ATC-1400A so that information may be exchanged between the two units.

45. MRB LENGTH Switch

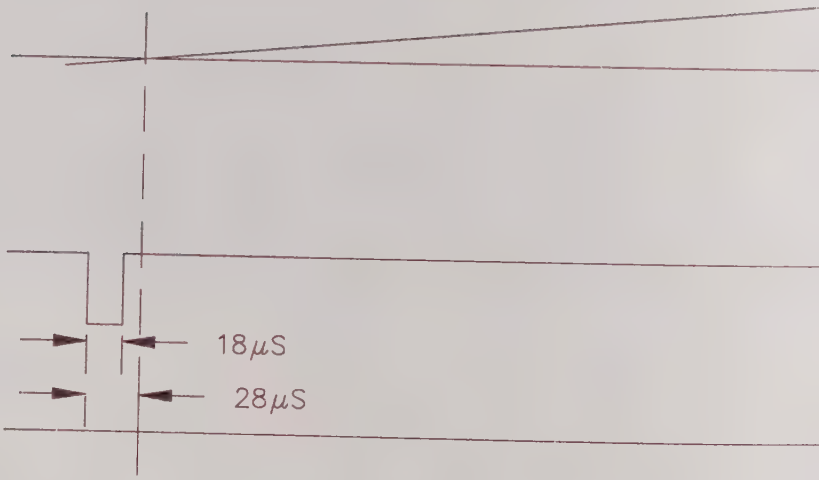
Controls the number of pulse pairs in G/A X mode or single pulses in G/A Y mode, A/A X mode and A/A Y mode in the Main Reference Burst. One or two pulse pairs (single pulses) may be added or subtracted from the nominal value.

NOMINAL SETTING - "NOM" Position

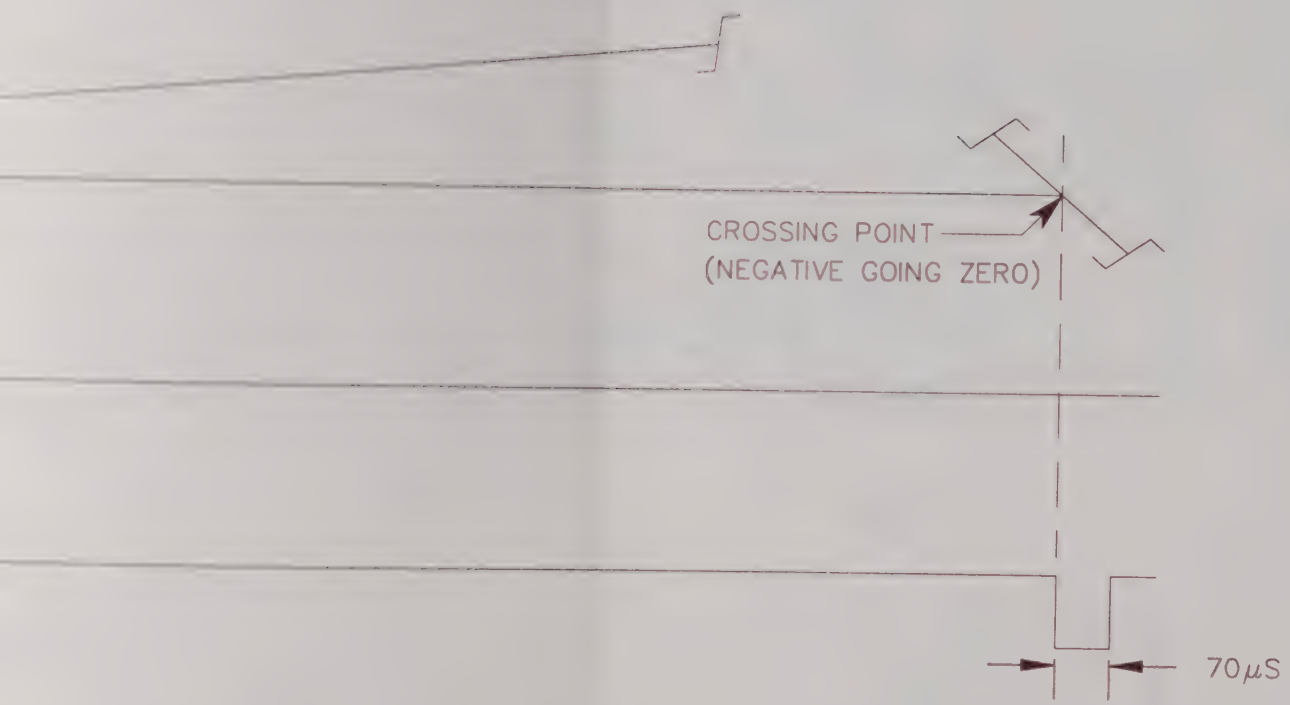
15Hz MOD (J15004)

15 Hz SYNC (J15008)

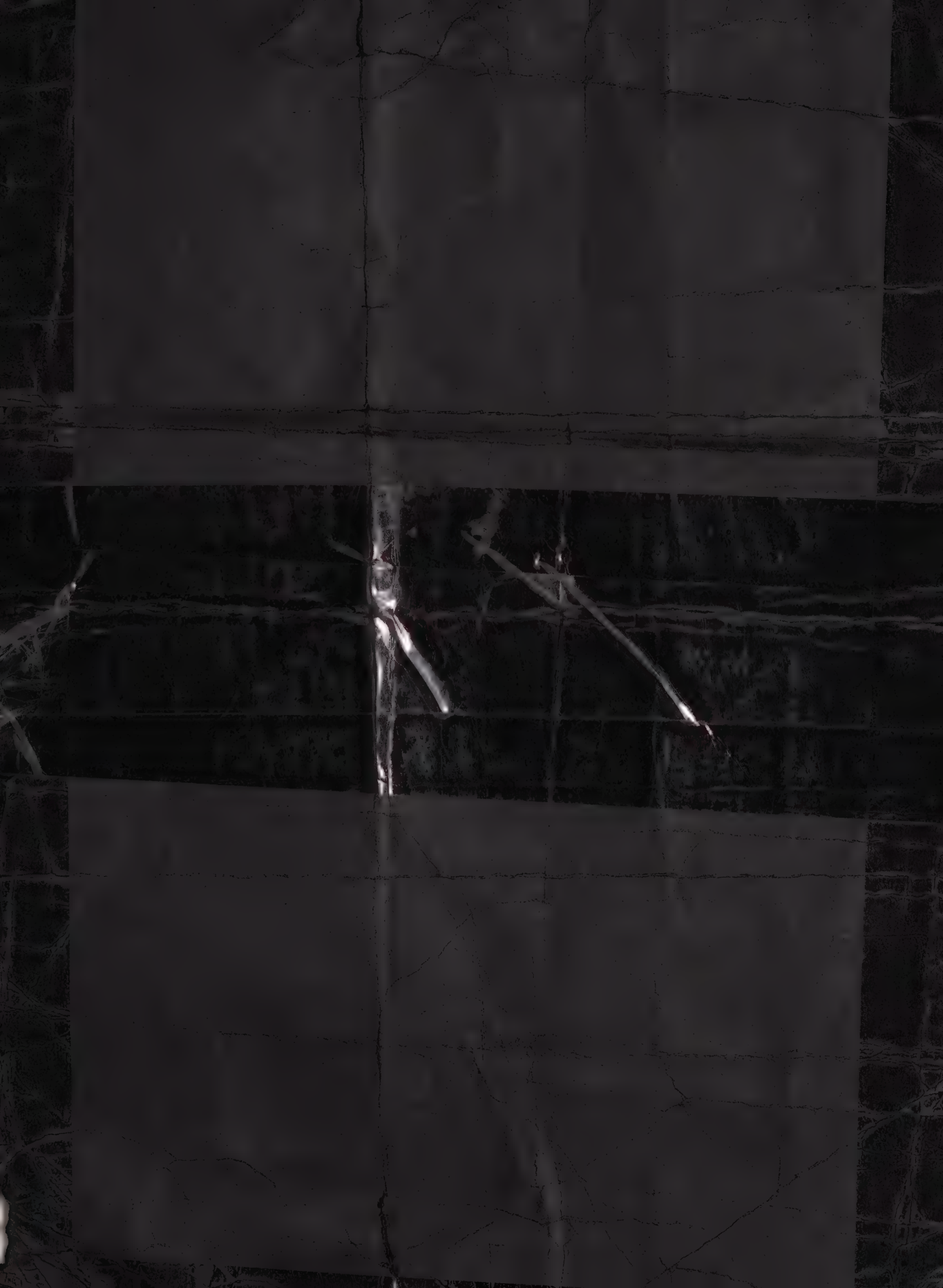
INVTACAN SYNC (J15010)
(BEARING=180.0 DEG.)

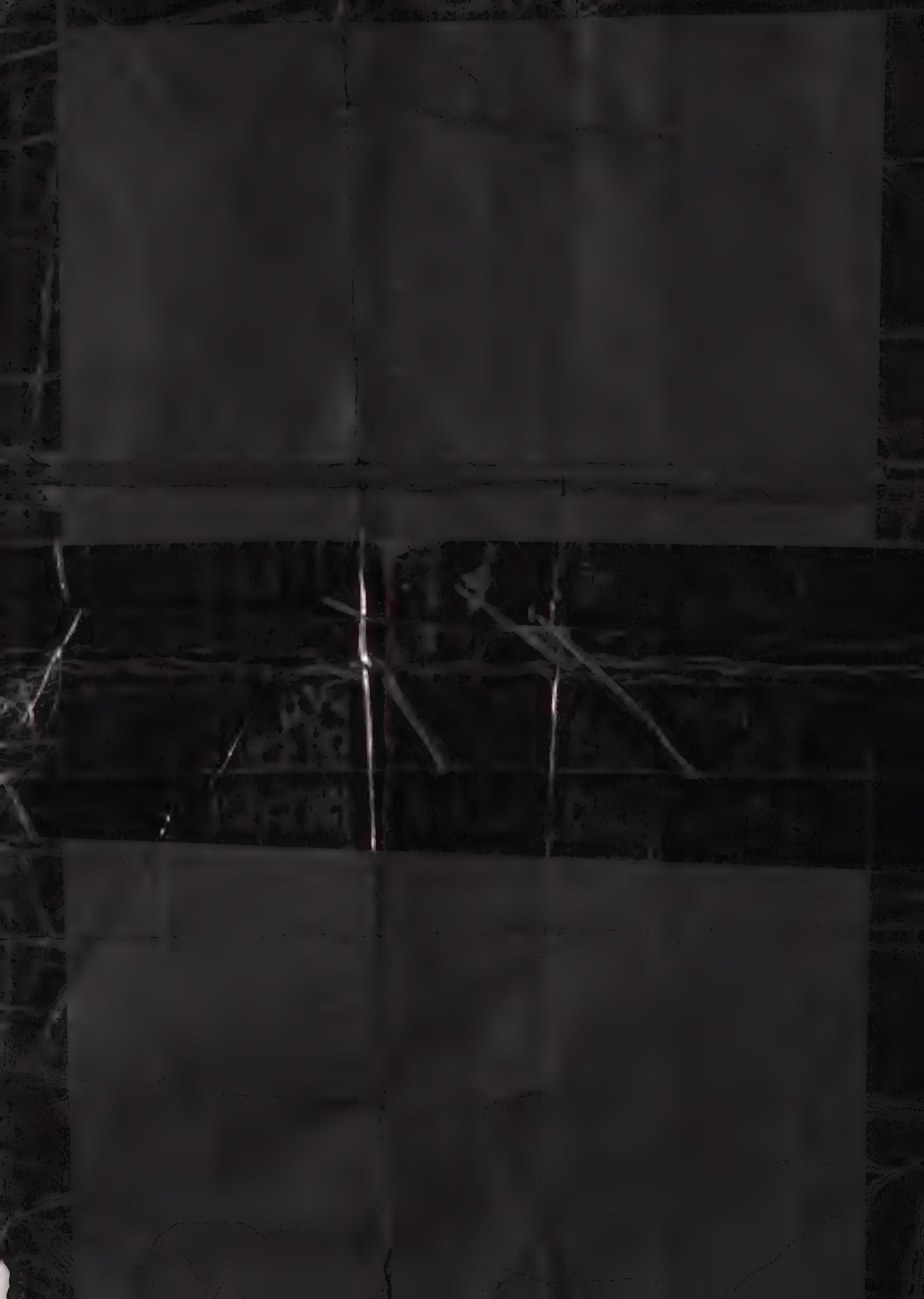


NOTE: ALL TIMING IS REFERENCED TO FALLING EDGE OF PULSES.

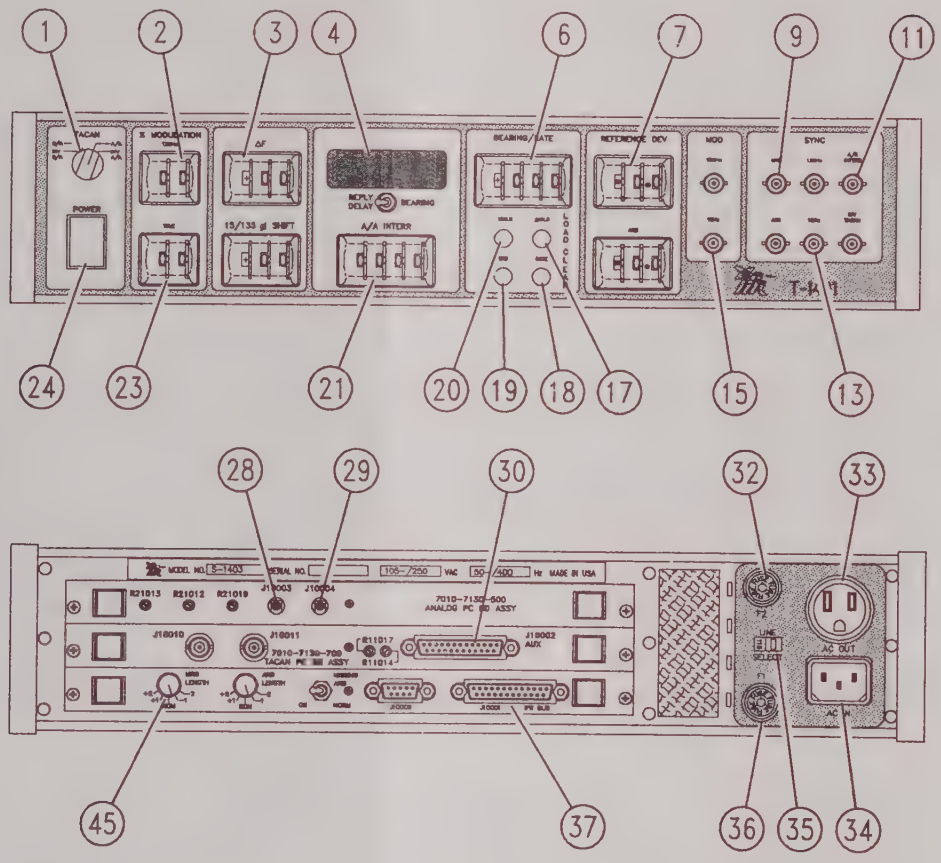


INVERSE Air-to-Air Test Function
Timing Chart
Figure 6

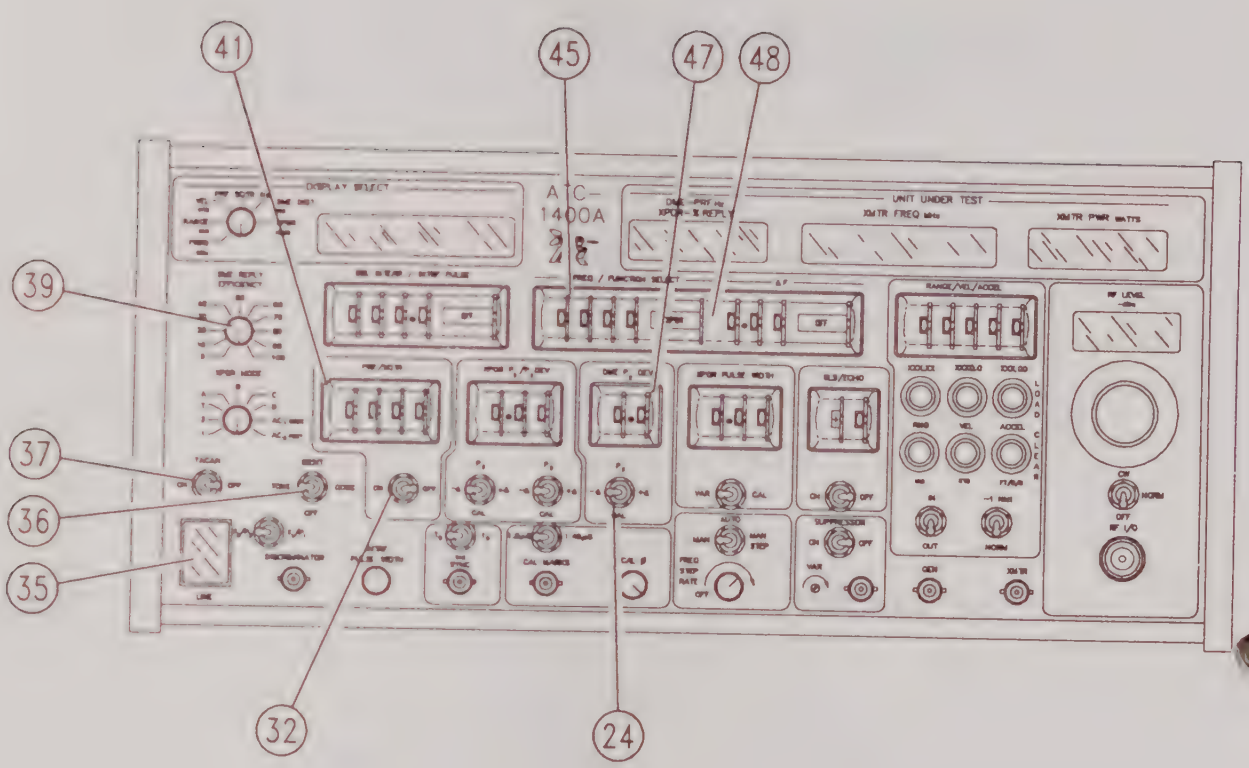




C. Air-to-Air (A/A) Test Function



(1) TACAN CONTROL
(3) ΔF Thumbwheels
(4) BEARING/REPLY DELAY Display
(6) BEARING/RATE Thumbwheels
(7) REFERENCE DEV MRB Thumbwheels
(9) MRB SYNC Connector (J15005)
(11) A/A INTERR SYNC Connector (J15009)
(13) 15 Hz SYNC Connector (J15008)
(15) 15 Hz MOD Connector (J15004)
(17) LOAD RATE Pushbutton
(18) CLEAR RATE Pushbutton
(19) CLEAR BRG Pushbutton
(20) LOAD BRG Pushbutton
(21) A/A INTERR Thumbwheels
(23) 15 Hz % MODULATION Thumbwheels
(24) POWER Switch
(28) COMP MOD Connector (J10003)
(29) EXT Connector (J1004)
(30) AUX Connector (J10002)
(32) F2 Fuse
(33) AC OUT Connector
(34) AC IN Connector
(35) LINE SELECT Switch
(36) F1 Fuse
(37) IFR BUS Connector
(45) MRB LENGTH Switch



24 DME DEV P2/CAL Switch
32 PRF/SQTR ON/OFF Switch
35 LINE Switch
37 TACAN ON/OFF Switch
39 DME REPLY EFFICIENCY Control
41 PRF/SQTR Thumbwheels
45 FREQ/FUNCTION SELECT Thumbwheels
47 DME P2 DEV Thumbwheels
48 ΔF Thumbwheels

T-1401 and ATC-1400A Front and Rear Panel Controls, Connectors and Indicators used in A/A Test Operation

Figure 7

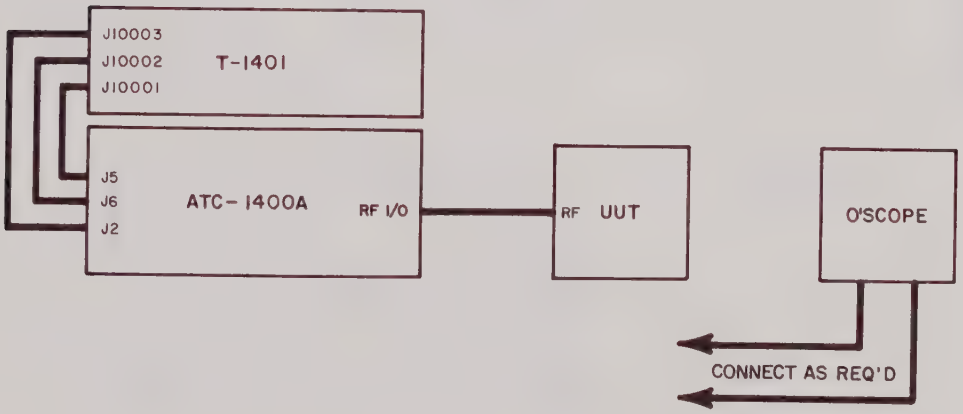
(1) T-1401 Description Of Controls, Connectors, and Indicators Used In A/A Test Function

A complete description of the T-1401 Test Auxiliary Controls, Connectors and Indicators, used in conjunction with the ATC-1400A, while performing the A/A Test Function is described in this paragraph.

A complete description of the ATC-1400A Controls, Connectors and Indicators, used in conjunction with the T-1401, while performing the A/A Test Function is described in Paragraph 2-4-B(2).

In the A/A Test Mode, the bearing information consists only of 15 Hz modulation and Main Reference Bursts (MRB). The MRB consists of 10 signal pulses spaced at 30 µS apart in both X and Y Modes. Range replies and squitter are single pulses. The test set generates signal pulse squitter and single pulse range replies. The test set also generates pulse interrogations and decodes the UUT range replies after a nominal delay of 62 µS in X Channel and 74 µS in Y Channel.

NOTE: Beacon A/A Mode can effectively be selected by turning OFF the MRBs, ARBs, 15 Hz Modulation and 135 Hz Modulation.



A/A Test Function Hook-up Diagram
Figure 8

ITEM NAME DESCRIPTION

1. TACAN Control

A/A Position - Sets the T-1401 to the AIR-TO-AIR Mode of Operation.

NOTE: When in the AIR-TO-AIR Mode of operation, the 135 Hz % MODULATION Thumbwheels (2), and REFERENCE DEV ARB Thumbwheels (16), ATC-1400A IDENT TONE/OFF/CODE Switch (36) and EQUALIZER/OFF Switch (64) are disabled.

NOMINAL SETTING - "A/A" Position

3. DELTA F Thumbwheels

Adjusts the TACAN timing reference oscillator from -3.9% to +3.9% of nominal value in 0.1% steps.

NOMINAL SETTING - "+0.0" Position

4. BEARING/REPLY DELAY Display

Normally displays the currently simulated bearing or reply delay output. If the T-1401 detects an error condition or the operator has selected an incompatible parameter value, an appropriate message will be displayed in place of the current bearing until the problem is resolved. Refer to Section 1-2-5 for an explanation of the error messages.

5. A/A REPLY Annunciator

Annunciates the reception of valid A/A replies from the UUT.

6. BEARING/RATE Thumbwheels

Desired value of bearing and bearing rate is set in degrees for bearing and degrees per second for bearing rate.

SELECTION	RANGE	THUMBWHEEL SETTING
Bearing	000.0 to 359.9	0000 to 3599
Bearing Rate	-39.0 to +39.0	-39X to +39X

ITEM	NAME	DESCRIPTION

28. COMP MOD Connector

15/135 Hz Composite modulation output from the T-1401 to the ATC-1400A.

29. IFR BUS Connector

Connect the T-1401 to the ATC-1400A so that information may be exchanged between the two units.

30. AUXILIARY Connector

Connects the T-1401 to the ATC-1400A to provide discrete signal interconnect.

32. F2 Fuse

Fuses the power to the AC OUT connector. When the LINE SELECT Switch (32) is in the 115 VAC position, F2 should be 1.0 amp fast blow. When the LINE SELECT Switch (32) is in the 230 VAC position, F2 should be a 0.5 amp fast blow.

33. AC OUT Connector

Convenience outlet normally used to power the ATC-1400A.

34. AC IN Connector

Power receptacle for applying either 115 VAC or 230 VAC single phase power to the T-1401. LINE SELECT Switch (32) must be set to the correct position before applying power.

35. LINE SELECT Switch

Selects the line voltage that will be applied to the T-1401.

ITEM NAME DESCRIPTION

36. F1 Fuse

Fuses the power to the T-1401 and the AC OUT Connector. When the LINE SELECT Switch (32) is in either the 115 VAC or 230 VAC position, F1 should be 3.0 amp fast blow.

37. IFR BUS Connector

Connect the T-1401 to the ATC-1400A so that information may be exhanged between the two units.

45. MRB LENGTH Switch

Controls the number of pulse pairs in G/A X mode or single pulses in G/A Y mode, A/A X mode, A/A Y mode in the Main Reference Burst. One or two pulse pairs (Single pulses) may be added or subtracted from the nominal value.

(2) ATC-1400A Description of Controls, Connectors and Indicators Used in A/A Test Function

24. DME DEV P2/CAL Switch (DME)

"CAL" Position - P_2 pulse remains in nominal position. DME DEV P_2/CAL Thumbwheels (47), have no effect on deviating P_2 pulses.

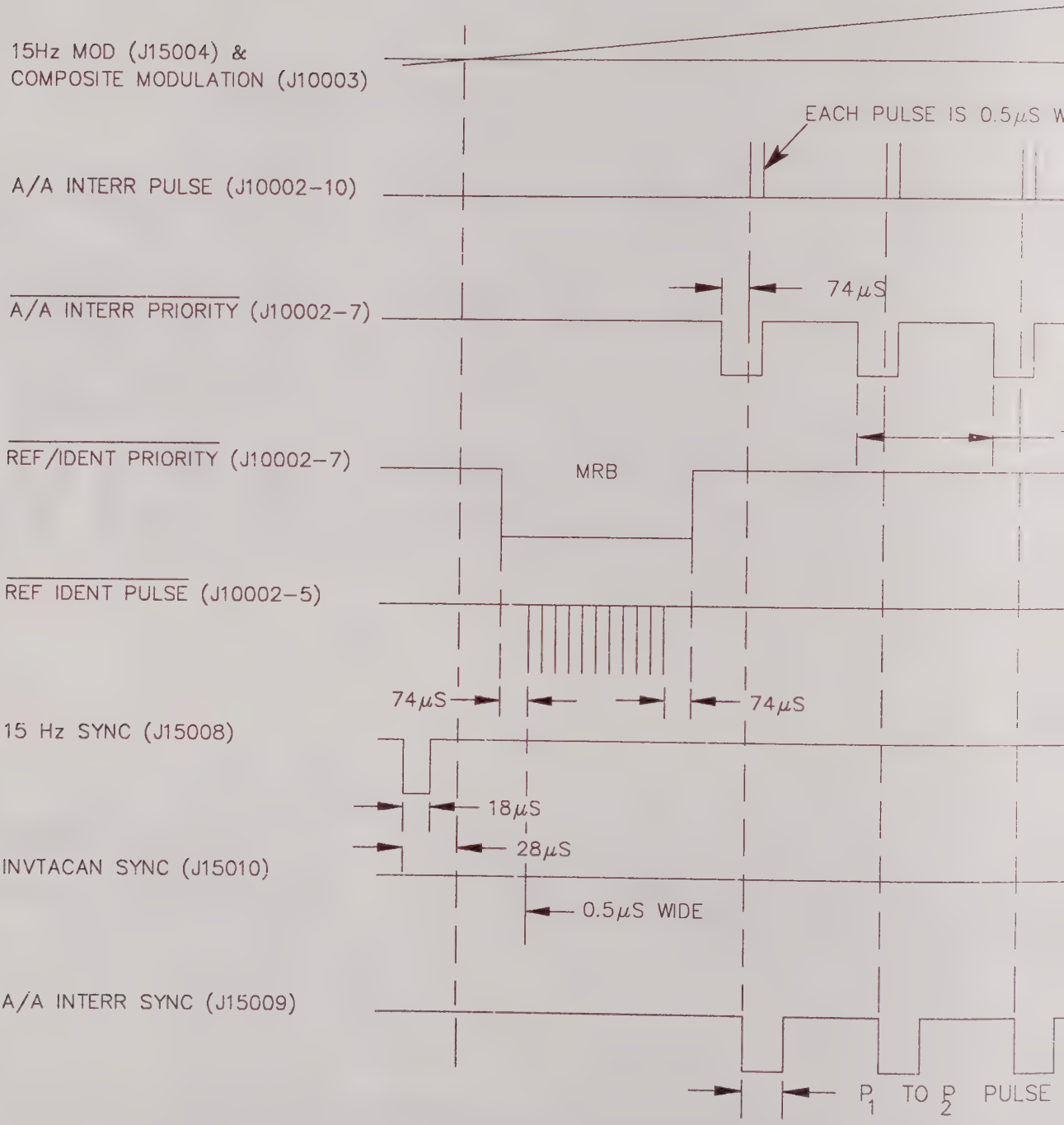
NOMINAL SETTING - "CAL" Position

32. PRF/SQTR ON/OFF Switch

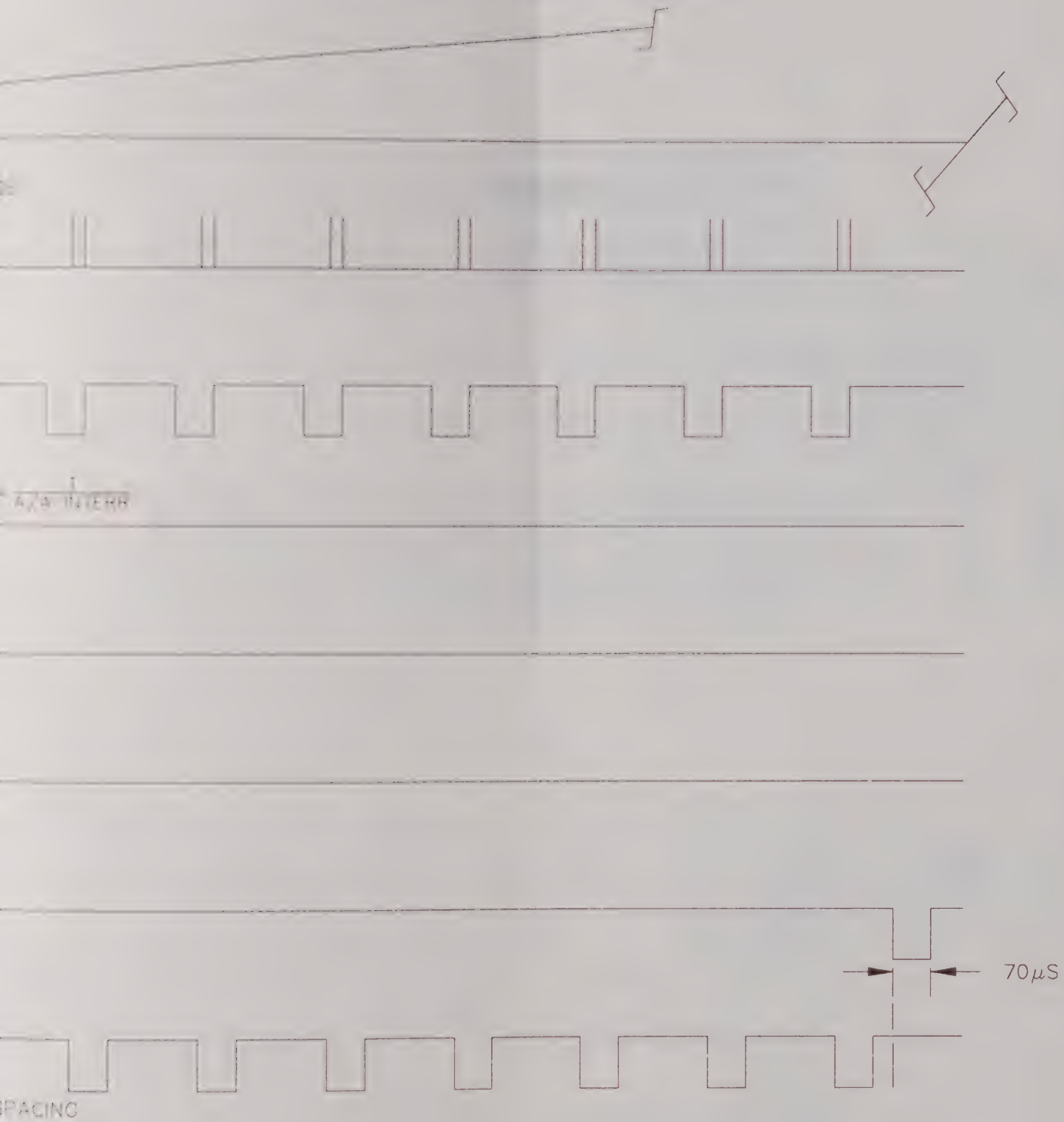
Two position switch which, placed in OFF position, will inhibit squitter in DME mode and interrogations in transponder mode.

35. LINE Switch

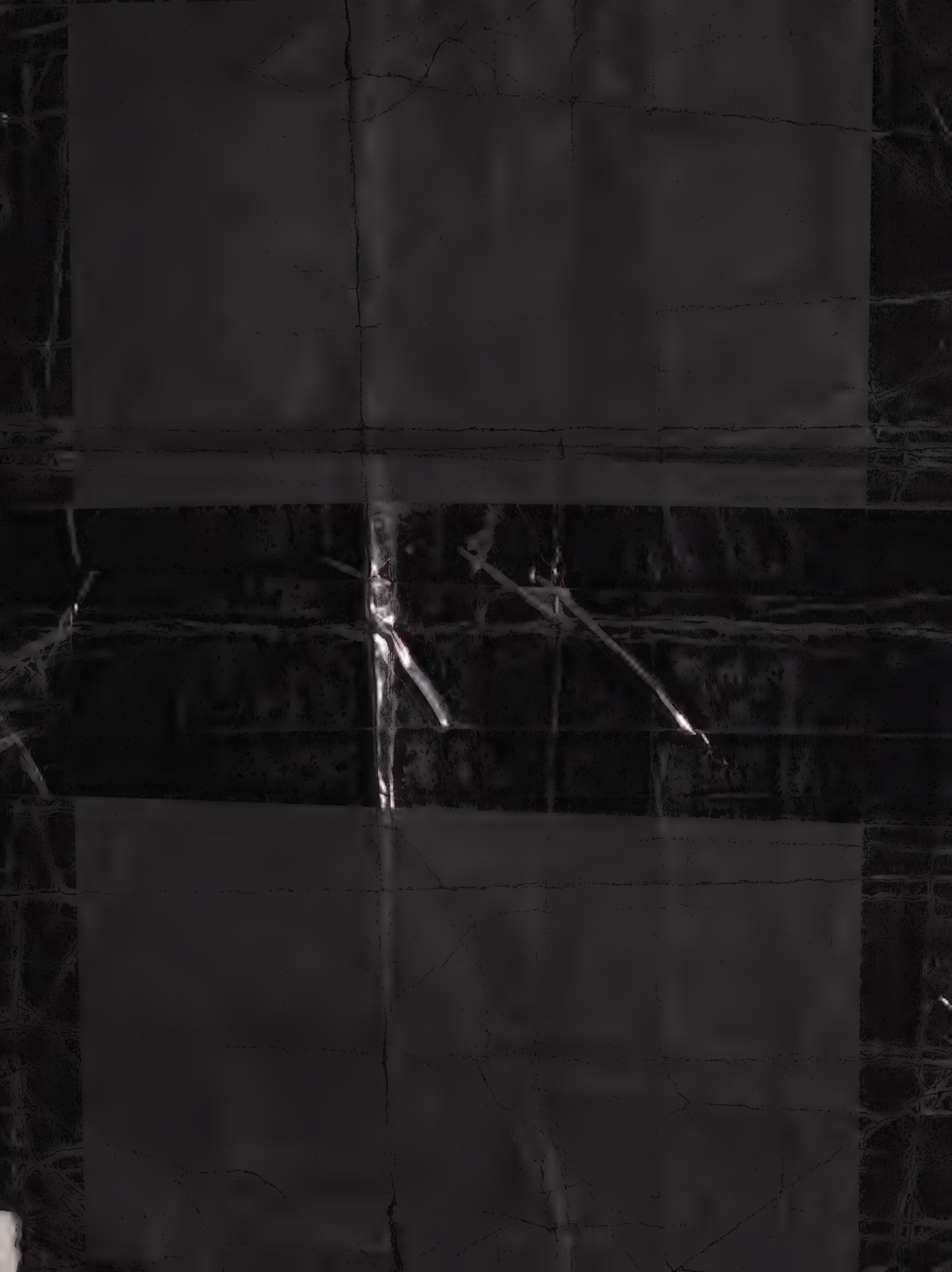
Applies external AC Power to ATC-1400A Test Set.

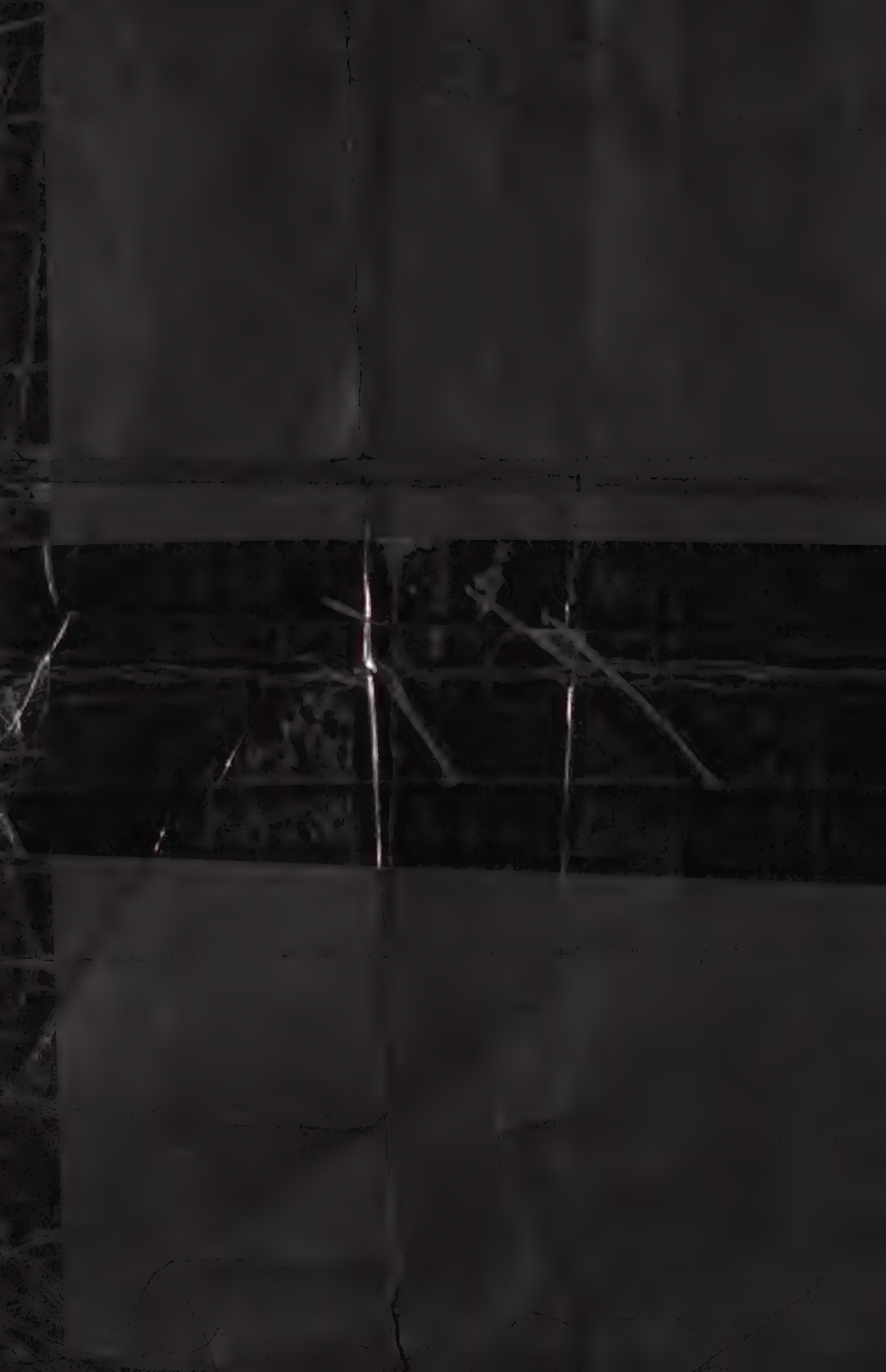


NOTE: ALL TIMING IS REFERENCED TO FALLING EDGE OF PULSES EXCEPT FOR A/A INTERR PULSE.

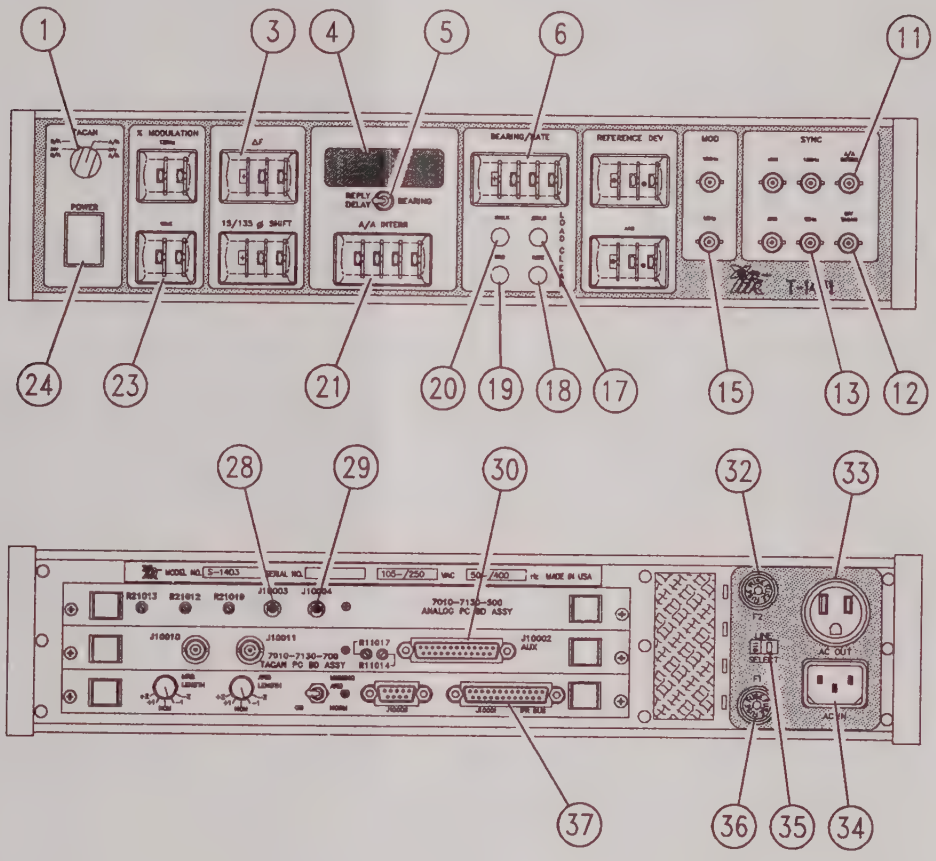


Air-to-Air Test Function
Timing Chart
Figure 9

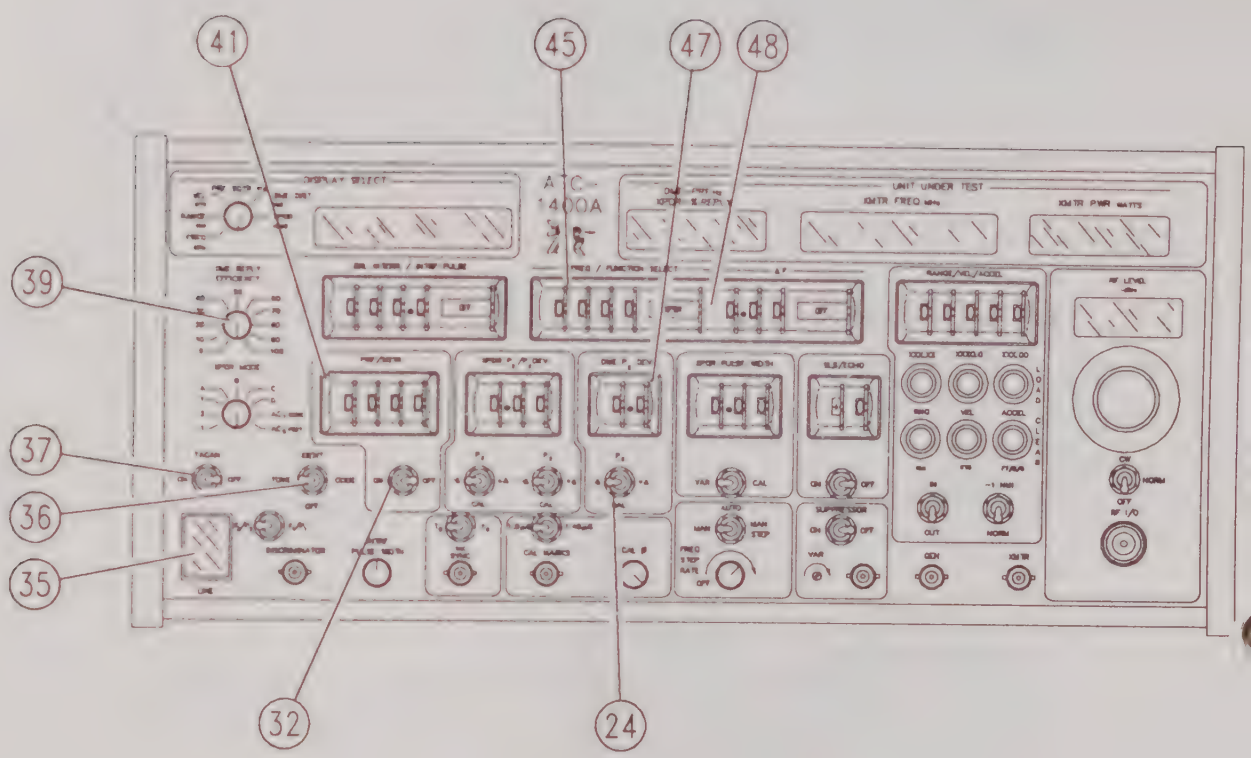




D. Inverse Air-to-Air (A/A) Test Function



(1) TACAN CONTROL
(3) ΔF Thumbwheels
(4) BEARING/REPLY DELAY Display
(5) DISPLAY SELECT Switch
(6) BEARING/RATE Thumbwheels
(11) A/A INTERR SYNC Connector (J15009)
(12) INV TACAN SYNC Connector (J15010)
(13) 15 Hz SYNC Connector (J15008)
(15) 15 Hz MOD Connector (J15004)
(17) LOAD RATE Pushbutton
(18) CLEAR RATE Pushbutton
(19) CLEAR BRG Pushbutton
(20) LOAD BRG Pushbutton
(21) A/A INTERR Thumbwheels
(23) 15 Hz % MODULATION Thumbwheels
(24) POWER Switch
(28) COMP MOD Connector (J10003)
(29) EXT Connector (J1004)
(30) AUX Connector (J10002)
(32) F2 Fuse
(33) AC OUT Connector
(34) AC IN Connector
(35) LINE SELECT Switch
(36) F1 Fuse
(37) IFR BUS Connector



24	DME DEV P2/CAL Switch	41	PRF/SQTR Thumbwheels
32	PRF/SQTR ON/OFF Switch	45	FREQ/FUNCTION SELECT Thumbwheels
35	LINE Switch	47	DME P2 DEV Thumbwheels
37	TACAN ON/OFF Switch	48	ΔF Thumbwheels
39	DME REPLY EFFICIENCY Control		

T-1401 and ATC-1400A Front and Rear Panel Controls, Connectors and Indicators used in Inverse A/A Test Operation

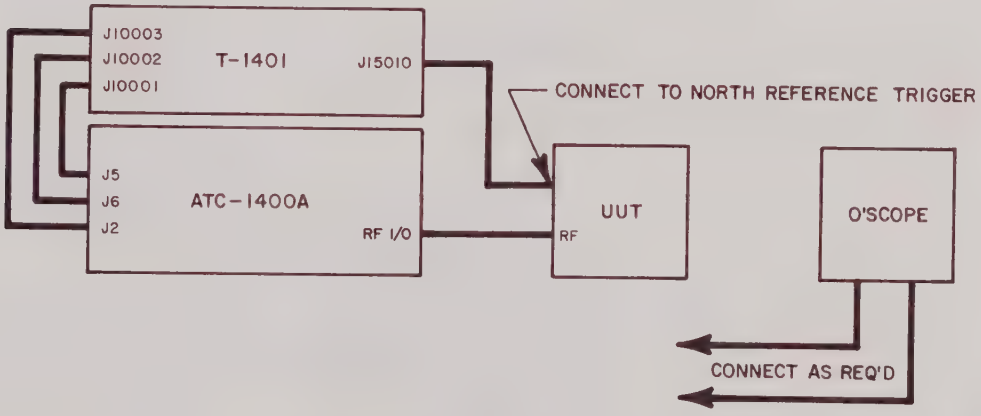
Figure 10

(1) T-1401 Description Of Controls, Connectors, and Indicators Used In INVERSE A/A Test Function

A complete description of the T-1401 Test Auxiliary Controls, Connectors and Indicators, used in conjunction with the ATC-1400A, while performing the INVERSE A/A Test Function is described in this paragraph.

A complete description of the ATC-1400A Controls, Connectors and Indicators, used in conjunction with the T-1401, while performing the INVERSE A/A Test Function is described in Paragraph 2-4-D(2).

In Inverse A/A Test Mode, the Airborne TACAN Beacon may determine the bearing to an airborne TACAN receiver/transmittter. In this case, a single pulse squitter generates timing between the negative going zero crossing of the 15 Hz modulated signal. An inverse SYNC Signal is generated coincident with the negative going zero crossing of the 15 Hz modulated signal to determine bearing to the ground station. ARB and MRB pulses are inhibited.



INVERSE A/A Test Function Hook-up Diagram
Figure 11

ITEM	NAME	DESCRIPTION

1. TACAN Control

INV A/A Position - Sets the T-1401 to the INVERSE A/A Mode of Operation.

NOMINAL SETTING: "INV A/A" Position

ITEM NAME DESCRIPTION

3. DELTA F Thumbwheels

Adjusts the TACAN timing reference oscillator from -3.9% to +3.9% of nominal value in 0.1% steps.

NOMINAL SETTING - "+0.0" Position

4. BEARING/REPLY DELAY Display

Normally displays the currently simulated bearing or reply delay output. If the T-1401 detects an error condition or the operator has selected an incompatible parameter value, an appropriate message will be displayed in place of the current bearing until the problem is resolved.

6. BEARING/RATE Thumbwheels

Desired value of bearing and bearing rate is set in degrees for bearing and degrees per second for bearing rate.

SELECTION	RANGE	THUMBWHEEL SETTING
Bearing	000.0 to 359.9	0000 to 3599
Bearing Rate	-39.0 to +39.0	-39X to +39X

11. A/A INTERR SYNC Connector

A negative going oscilloscope sync pulse whose leading edge occurs immediately prior to the first pulse of an A/A interrogation pulse pair is output at this connector.

12. INV TACAN SYNC Connector

A positive-going North Reference Trigger pulse is output at this connector. The 15 Hz bearing in INV Mode is determined by the time delay between the rising edge of this pulse to the negative-going zero crossing of the 15 Hz modulating signal. This sync pulse is output only when INV G/A or INV A/A Modes have been selected on TACAN Control (1).

13. 15 Hz SYNC Connector

A negative going oscilloscope sync pulse whose leading edge occurs at the positive going zero crossing of the 15 Hz modulation signal is output at this connector.

ITEM	NAME	DESCRIPTION

15. 15 HZ MOD Connector

A sample of the 15 Hz modulation signal is output at this connector. The level is adjusted from 0 V p-p to 2.5 V p-p as the 15 HZ % MODULATION Thumbwheels are set from 00% to 39%.

17. LOAD RATE Pushbutton

Programs a bearing rate from -39.0 degrees per second to +39.0 degrees per second as selected on the BEARING/RATE Thumbwheels (6).

18. CLEAR RATE Pushbutton

Clears the previously loaded bearing rate information to 00.0 degrees per second.

19. CLEAR BRG Pushbutton

Clears the previously loaded bearing information to 000.0 degrees.

20. LOAD BRG Pushbutton

Programs a bearing from 000.0 degrees to +359.9 degrees as selected on the BEARING/RATE Thumbwheels (6).

21. A/A INTERR Thumbwheels

Programs an A/A interrogation rate from 0000 interrogations per second to 3999 interrogations per second in 1 interrogation per second steps when in the A/A mode.

NOMINAL SETTING: "0030" Position

23. 15 HZ % MODULATION Thumbwheels

Programs the percent modulation of the 15 Hz component of TACAN modulation between 0% and 39% in 1% steps.

NOMINAL SETTING: "20%" Position

24. POWER Switch

Applies external AC power to the T-1401 and to the ATC-1400A when it is connected to the AC OUT (33) convenience outlet on the rear of the T-1401.

ITEM	NAME	DESCRIPTION

28. COMP MOD Connector

15/135 Hz Composite modulation output from the T-1401 to the ATC-1400A.

29. EXT F Connector

Input for external frequency source for the TACAN signal timing reference.

NOTE: Input is enabled through the IFR BUS.

30. AUXILIARY Connector

Connects the T-1401 to the ATC-1400A to provide discrete signal interconnect.

32. F2 Fuse

Fuses the power to the AC OUT Connector. When the LINE SELECT Switch (35) is in the 115 VAC position, F2 should be 1.0 amp fast blow. When the LINE SELECT Switch (35) is in the 230 VAC position, F2 should be a 0.5 amp fast blow.

33. AC OUT Connector

Convenience outlet normally used to power the ATC-1400A.

34. AC IN Connector

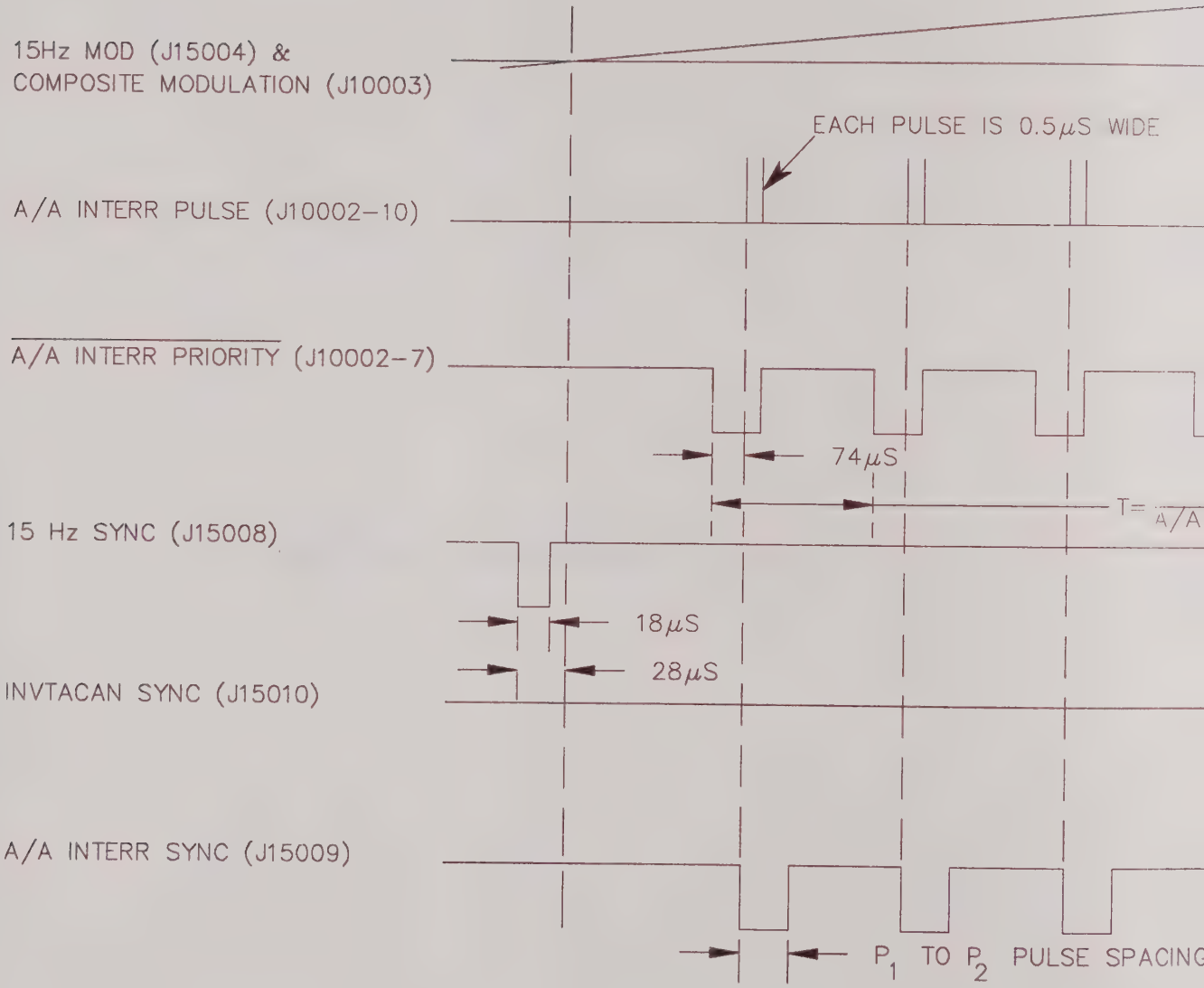
Power receptacle for applying either 115 VAC or 230 VAC signal phase power to the T-1401. LINE SELECT Switch (35) must be set to the correct position before applying power.

35. LINE SELECT Switch

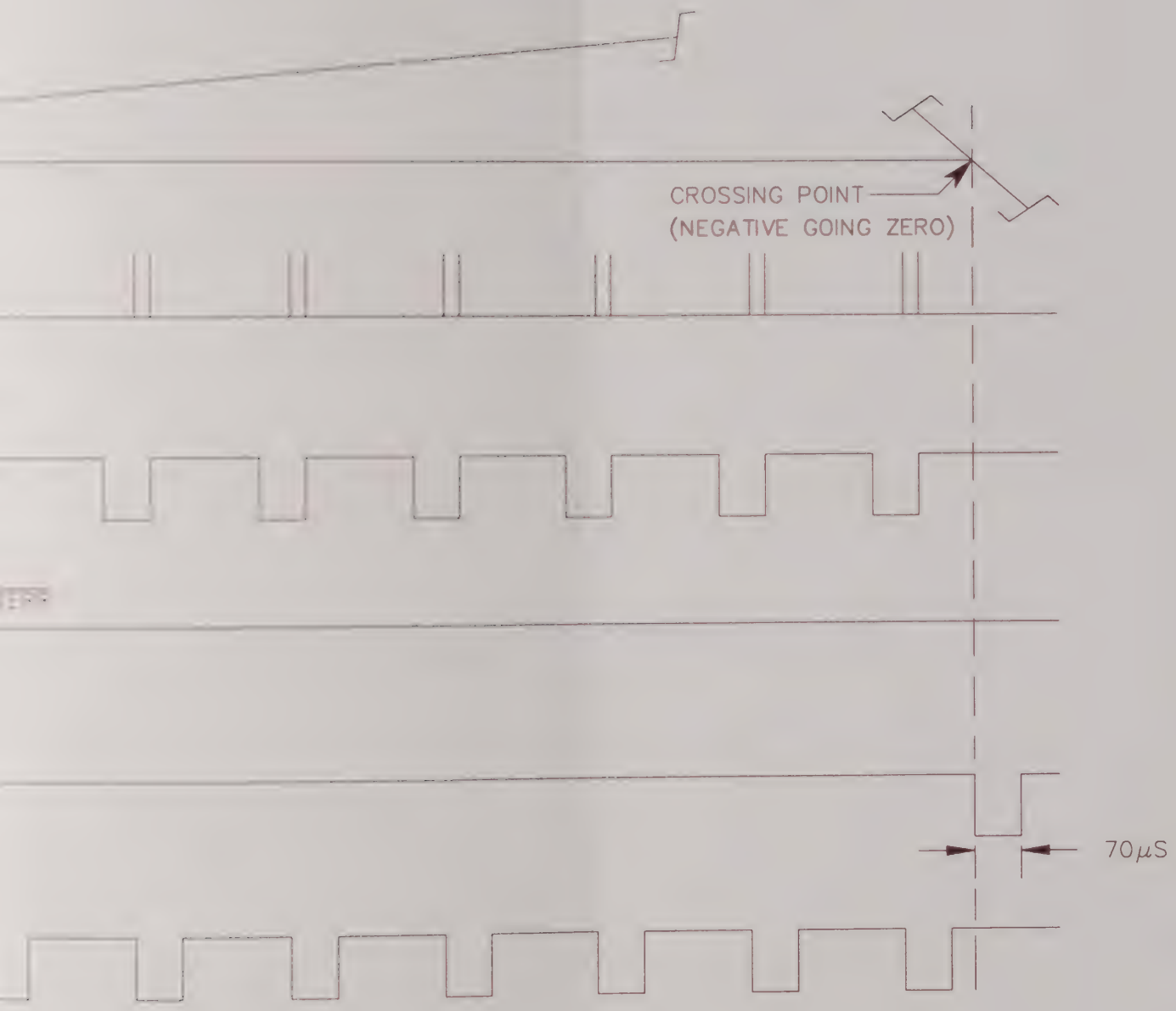
Selects the line voltage that will be applied to the T-1401.

36. F1 Fuse

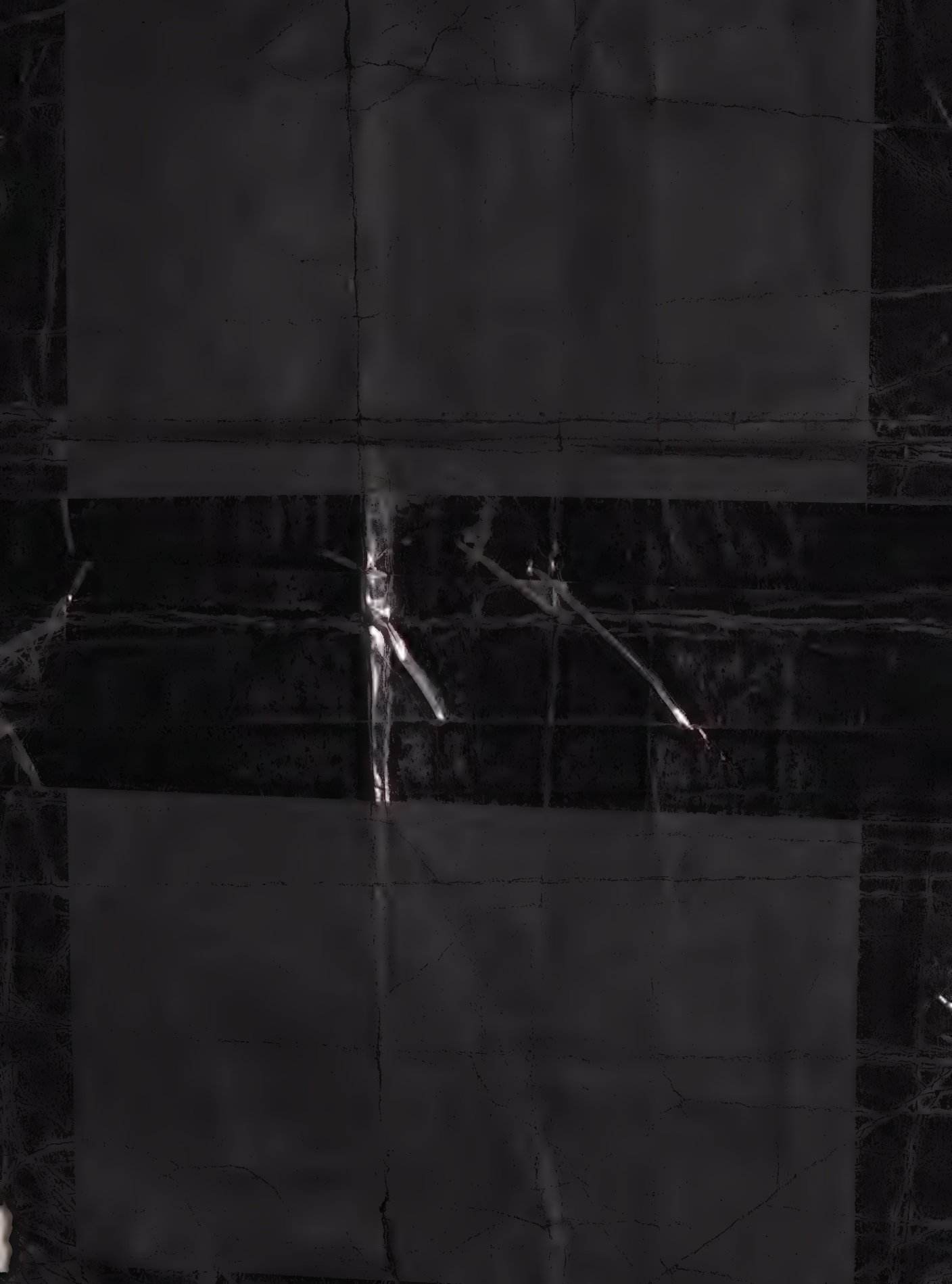
Fuses the power to the T-1401 and the AC OUT Connector. When the LINE SELECT Switch (35) is in either the 115 VAC or 230 VAC position, F1 should be a 3.0 amp fast blow.

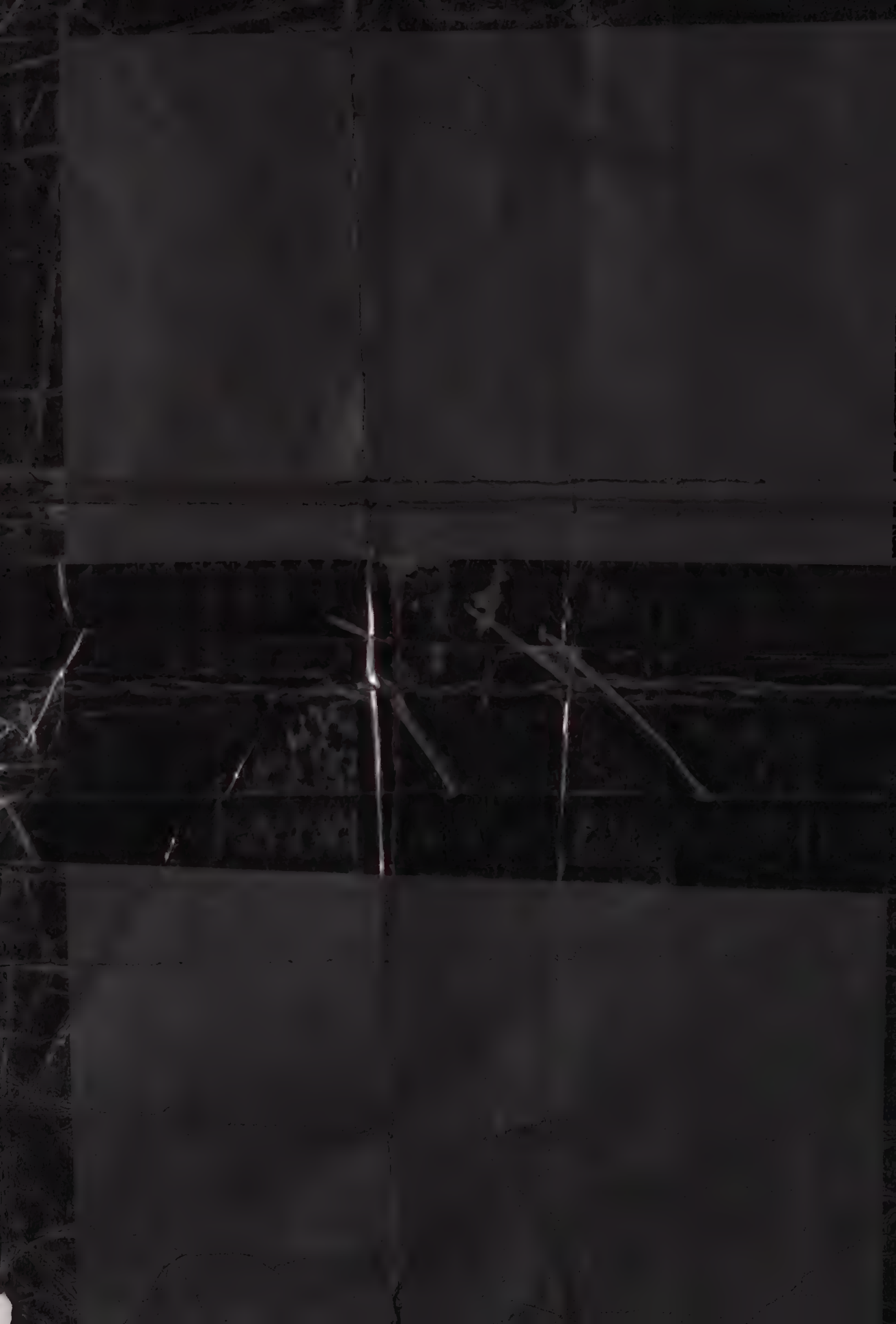


NOTE: ALL TIMING IS REFERENCED TO FALLING EDGE OF PULSES EXCEPT FOR A/A INTERR PULSE.



INVERSE Air-to-Air Test Function
Timing Chart
Figure 12





OPERATION/MAINTENANCE MANUAL
W/ILLUSTRATED PARTS LIST
TACAN TEST SYSTEM

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5. Remote (GPIB) Operations

The GPIB Commands contained within this paragraph apply to all T-1401 Test Units when interfaced with the ATC-1400A, and should be used in conjunction with the commands listed in the ATC-1400A Operation Manual.

Refer to the operating instructions in the ATC-1400A Operation Manual for a complete explanation on remote communication with the T-1401 test auxiliary.

A. Remote (GPIB) Operating Procedures

Remote communication with the T-1401 is provided by use of the General Purpose Interface Bus (GPIB) via the ATC-1400A which conforms to the latest IEEE standard 488-1978. The ATC-1400A performs the following IEEE-488 subsets: SH1, AH1, T8, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1 and C0. These subsets mean the ATC-1400A is a talker, listener, primary address only and has remote and local capability, device clear capability, device trigger capability or controller capability.

All communication with the T-1401 over the GPIB bus is implemented with ASCII encoded character strings via the ATC-1400A GPIB hardware. That is, the T-1401 does not have the actual GPIB bus hardware, and relies on the ATC-1400A to do the job. T-1401 GPIB commands are passed to the ATC-1400A which in turn will acknowledge the GPIB command is for the T-1401 and will forward the T-1401 GPIB command string over the T-1401 via the IFR BUS. Likewise, if the T-1401 needs to transmit a GPIB command, it will send the string to the ATC-1400A via the IFR Bus, which will in turn, pass it on to the GPIB BUS.

When the ATC-1400A receives the first command, the T-1401 will lock out all front panel controls and display "AAAA" in the Bearing/Reply Delay window. The AAAA display will remain until the T-1401 is instructed to display Bearing or Reply Delay.

B. Command and Data Structure

All communication with ATC-1400A/T-1401 is done with uppercase ASCII character strings, which are designed to replace the front panel controls. There is a one-for-one correspondence between the ASCII commands and ATC-1400A/ T-1401 front panel switches and displays with the exception of a few functions with which the data ranges are increased. The front panel switches can be used to program the initial condition or local state of the ATC-1400A/T-1401. The device clear message (GPIB DCL) will also reset the ATC-1400A/T-1401 to the current front panel conditions.

C. ASCII Input Commands

The T-1401 receives GPIB commands from the ATC-1400A. The ATC-1400A transmits GPIB command strings to the T-1401 which the ATC-1400A receives from two sources. Input commands to the interpreter will be one of four types: (1) Set a value (using '='), (2) Set/Reset Boolean

types, (3) Acquire a specified value (using '?'), or (4) Enable (execute) a command (using '.').

D. GPIB Input Command Sources

One source of ASCII GPIB commands originate from the talker of the GPIB BUS with a directed destination to the T-1401. The ATC-1400A recognizes the ASCII string is destined for the T-1401 (sees the "AX1=") command prefix and passes remaining ASCII string to T-1401 via the IFR BUS without massaging any of the remaining string.

E. ASCII Commands from the ATC-1400A

The other origination of GPIB ASCII command strings occurs from within the ATC-1400A itself. The ATC-1400A passes the T-1401 GPIB commands transparent to the GPIB user. The T-1401 processes these commands as though the commands originated from the GPIB talker. These commands usually occur when the GPIB bus requests (in hardware) special functions. Device clear and go to local (DCL and GTL) commands are examples of such requests.

F. GPIB ASCII Command Syntax and Format

All ASCII commands sent to the ATC-1400A with the command line prefix "AX1=" will be passed to the T-1401 via the IFR BUS. When the ASCII string begins with these four characters, the characters are stripped and the remaining string will be sent on to the T-1401. This means that an IEEE programmer must not send a command intended for the ATC-1400A unit to process in this string. The GPIB transfer can only occur if, and only if, the IFR BUS communication has been previously established.

The command string sent to the ATC-1400A may be up to sixty-four characters (including the AX1= characters and spaces) with spaces being optional, as they are ignored internally. The commands may be packed together in random order within the ASCII string separated with command delimiters.

The command delimiter used in the T-1401 system is the ":" colon character. GPIB commands that use "?" and "." in them do not require the colon delimiter after them prior to another GPIB command. For example, GPIB commands "AX1=B?AA" and "AX1=B?:AA" would both be valid syntax.

G. ASCII Input Command Format

The commands and their variable formats and ranges are explained in detail in paragraph K. In general, variables programmed greater than the allowable range are set to the maximum limit and variables less than the allowable range are set to the minimum limit. Invalid commands and data are ignored. The T-1401 GPIB commands: "GA, B=25, A1, B?, AAR?" could be transmitted to the T-1401 as shown below:

"AX1=GA:B=25:A1:B?AAR?" or
"AX1=GA: B=25: A1: B?" AAR?"

H. GPIB ASCII Output Data

Command instructions which pass data from the T-1401 to the GPIB are handled also via the IFR BUS. Resulting data from all measurements are stored in a buffer, one measurement at a time, separated with the delimiter, in the order requested. If a syntax error occurred in the received GPIB command string, the T-1401 will place "?" in the buffer. After data is placed in this buffer, a flag is set to indicate a GPIB transmit is desired, where later the IFR BUS task will transmit the string to the ATC-1400A.

Once the GPIB application has made measurement requests, no new measurements should be requested until all previous results have been returned, as this action will destroy the data remaining to be transmitted.

I. ASCII INPUT Command Format Examples

(1) Valid Command Syntax Example

The following example illustrates a proper request from the GPIB application to put the T-1401 into Ground-to-Air TACAN Mode, bearing measurement, and request to see if the TACAN unit is receiving valid Air-to-Air replies.

Transmit request:
"AX1=GA: B=25: A1: B?: AAR?"

Reply response:
"1:25.0:1:"

Receiving valid Air-to-Air replies
Measured bearing is 25 degrees

(2) Invalid Command Syntax Example

The following example illustrates how the T-1401 handles an error within the received GPIB command. Example 1-2-6I(1) above is used with an error inserted in two places.

Transmit request:
"AX1=GA1, BZ=25: A1 B": AAR?

No terminator used
Invalid command

Reply response:
1:?:1:"

(3) GPIB Command Syntax Omitting Unneeded Terminators

The T-1401 GPIB command interpreter allows omission of the terminator between commands. The interpreter will allow the GPIB application to omit the colon (":") terminator after "?"

or "." commands. These commands are assumed to be complete by the interpreter and will be processed accordingly. An example is illustrated as follows:

Valid transmit request with terminators: "AX1=GA: B=25: A1: B?" AAR?"

Reply response: "1:25.0:1:"

Receiving valid Air-to-Air replies
Measured bearing is 25 degrees

Valid transmit request without non-required terminators:

"AX1=GA: B=25: A1: B?: AAR?" or
"AX1=GA:B=25:A1:B?AA?"

Reply response: "1:25.01:1:"

Receiving valid Air-to-Air replies
Measured bearing is 25 degrees

Invalid transmit request without required terminators:
"AX1=GA B=25 A1 B? AAR?"

Interpreter delimits see AAR? Terminator required Terminator required Terminator required

Reply response:
"1:?:1:"

Receiving valid Air-to-Air replies
Interpreter did not know "GAB=25A1B?"

J. Quick Reference ASCII Command Table

An alphabetical listing of the GPIB ASCII commands used in remote control operation of the T-1401 is listed in 1-2-5J(a). The listing is as seen from the GPIB application. A definition of the list is as follows:

1. All commands are in ASCII code

2. All T-1401 auxiliary unit GPIB command strings will begin with "AX1=".

3. Data listed under the Data List column reflects input/output data of the T-1401. Data shown in parenthesis is input data, that not enclosed in parenthesis is output data, and a dash is used for commands having no input/output data.

4. A brief description of the commands are listed under the instruction column.

3. Data listed under the Data List column reflects input/output data of the T-1401. Data shown in parenthesis is input data, that not enclosed in parenthesis is output data, and a dash is used for commands having no input/output data.

4. A brief description of the commands are listed under the instruction column.

COMMAND	DATA	INSTRUCTION
AAI=	XXXX	Set Air-to-Air interrogation (0 to 3999)
AA	--	Select Air-to-Air TACAN Mode
AAR?	(X)	Get Air-to-Air reply state (0/1)
A=	+/-XX.X	Set ARB deviation (-39.9 to +39.9)
AØ	--	Set Auxiliary Reference Bursts OFF
A1	--	Set Auxiliary Reference Bursts OFF
ADP=	+/-X	Set ARB delta pulse (-2 to +2)
AMISSØ	--	Allow first ARB after MRB
AMISS1	--	Remove first ARB after MRB
B=	XXX.X	Set Bearing degree (0 to 359.9)
B?	(XXX.X)	Get measured Bearing (0 to 359.9)
BR=	+/-XX.X	Set Bearing Rate (-39 to +39)
DF=	+/-X.X	Set delta frequency (-3.9 to +3.9)
DISPB.	--	Display Bearing
DISPRD.	--	Display Air-to-Air Reply Delay
GA	--	Select Ground-to-Air TACAN Mode
INVGA	--	Select Inverse G/A TACAN Mode
INVAA	--	Select Inverse A/A TACAN Mode
M=	+/-XX.X	Set MRB deviation (-39.9 to +39.9)
MØ	--	Turn Main Reference Bursts OFF

Table 1 - GPIB ASCII Command Listing

COMMAND	DATA	INSTRUCTION
M1	---	Turn Main Reference Bursts ON
MDP=	+/-X	Set MRB delta pulse (-2 to +2)
MOD15=	XX	Set percent 15 Hz modulation (0 to 39)
MOD135=	XX	Set percent 135 Hz modulation (0 to 39)
PH=	+/-XX	Set 15/135 Hz phase shift (-39 to +39)
RD?	(XXX.X)	Get Air-to-Air Reply Delay

Table 1 (Cont'd) - GPIB ACSII Command Listing

K. Explanation of Codes for Common Commands

In the following paragraphs [(a) to (z)] is a detailed description of the ASCII commands used in the function of operation of the T-1401, as seen from the GPIB application.

1. All Commands are in ASCII code.

2. Data listed under the data list column reflects input/output data of the T-1401. Data shown enclosed in parenthesis is input data, that not enclosed in parenthesis is output data, and "None" indicates no input/output data flow.

(a) ---------- COMMAND: AA=XXXX ----------

INSTRUCTION FORMAT:
ASCII command - AAI=
Data list - XXXX

COMMAND DEFINITION: Instructs the T-1401 Air-to-Air interrogations to be fixed at XXXX PRF.

DATA LIST DEFINITION: A maximum of three digits are output to the T-1401, with a range of 0 to 3999 PRF.

EXAMPLE: ASCII character string "AX1=AAI=2525" instructs the T-1401 to produce Air-to-Air interrogation pulses at a 2525 PRF.

ERROR CONDITION: Data value >3999 PRF

ERROR CONDITION RESPONSE: Defaults to 3999 PRF

(b) ---------- COMMAND: AA ----------

INSTRUCTION FORMAT:
ASCII command - AA
Data list - None

COMMAND DEFINITION: Selects T-1401 Air-to-Air TACAN Mode. The T-1401 has four (4) possible TACAN Modes: Ground-to-Air, Air-to-Air, Inverse G/A and Inverse A/A. (GA, AA, INVGA, INVAA commands respectively). Only one TACAN Mode can be active at any given time.

DATA LIST DEFINITION: No input/output data.

EXAMPLE: ASCII character string "AX1= AA" sets the T-1401 in Air-to-Air TACAN Mode.

ERROR CONDITION: N/A

ERROR CONDITION RESPONSE: N/A

(c) ---------- COMMAND: AAR?----------

INSTRUCTION FORMAT:
ASCII command - AAR?
Data list - (X)

COMMAND DEFINITION: Instructs the T-1401 to read the Air-to-Air valid reply delay circuit and determine if reply is valid, then transfer the results to the GPIB when the ATC-1400A is addressed to talk.

DATA LIST DEFINITION: Data sent from the T-1401 of the Air-to-Air reply status is one character. The returned value corresponds with Boolean values 0 or 1 indicating TRUE or FALSE respectively.

EXAMPLE: ASCII string "AX1=AAR?"

ERROR CONDITION: Data value out of range.

ERROR CONDITION RESPONSE: Value defaults to FALSE.

(d) ---------- COMMAND: A=+/-X.X ----------

INSTRUCTION FORMAT:
ASCII command - A=
Data list - +/-X.X

COMMAND DEFINITION: Instructs the T-1401 to set Auxiliary Reference Bursts' reference deviation setting to +/-X.X microseconds. This command works in conjunction with the "AØ" and "A1" commands.

DATA LIST DEFINITION: A maximum of four (4) digits including the decimal point are output to the T-1401, with a range of -3.9 to +3.9 microseconds.

EXAMPLE: ASCII character string "AX1=A=2.5" instructs the T-1401 to deviate the ARB's 2.5 μs from the nominal.

ERROR CONDITION: Data value out of range.

ERROR CONDITION RESPONSE: Defaults to negative maximum limit if data value is under range and defaults to positive maximum limit if data value is over range.

(e) ---------- COMMAND: AØ ----------

INSTRUCTION FORMAT: ASCII command - AØ
Data list - None

COMMAND DEFINITION: Instructs T-1401 to select Auxiliary Reference Bursts to an OFF state.

DATA LIST DEFINITION: No input/output data.

EXAMPLE: ASCII character string "AX1= AØ" turns off the Auxiliary Reference bursts.

ERROR CONDITION: N/A

ERROR CONDITION RESPONSE: N/A

(f) ---------- COMMAND: A1 ----------

INSTRUCTION FORMAT:
ASCII command - A1
Data list - None

COMMAND DEFINITION: Instructs the T-1401 to select the Auxiliary Reference Bursts to an ON state.

DATA LIST Definition: No input/output data.

EXAMPLE: ASCII character string "AX1=A1" turns on the Auxiliary Reference bursts.

ERROR CONDITION: N/A

ERROR CONDITION RESPONSE: N/A

(g) ---------- COMMAND: ADP=+/-X ----------

INSTRUCTION FORMAT:
ASCII command - ADP=
Data list - +/-X

COMMAND DEFINITION: Instructs T-1401 to set the Auxiliary Reference Bursts' pulse quantity to +/-X from the nominal amount.

DATA LIST DEFINITION: A maximum of two ASCII digits are output to the T-1401, with a range of -2 to +2 pulses.

EXAMPLE: ASCII character string "AX1= ADP= -2" instructs the T-1401 to subtract 2 pulses (or pairs of pulses) from the Auxiliary Reference Bursts.

ERROR CONDITION: Data value out of range.

ERROR CONDITION RESPONSE: Defaults to zero.

(h) ---------- COMMAND: AMISSØ ----------

INSTRUCTION FORMAT:
ASCII command - AMISSØ
Data list - None

COMMAND DEFINITION: Instructs the T-1401 to enable the first Auxiliary Reference Burst after the Main Reference Burst.

DATA LIST DEFINITION: No input/output data.

EXAMPLE: AX1= AMISS1"

ERROR CONDITION: N/A

ERROR CONDITION RESPONSE: N/A

(i) ---------- COMMAND: AMISS1 ----------

INSTRUCTION FORMAT:
ASCII command - AMISS1
Data list - None

COMMAND DEFINITION: Removes the first Aux. Reference Burst after the Main Reference Burst.

DATA LIST DEFINITION: No input/output data.

EXAMPLE: "AX1= AMISS1"

ERROR CONDITION: N/A

ERROR CONDITION RESPONSE: N/A

(j) ---------- COMMAND: B=XXX.X ----------

INSTRUCTION FORMAT:
ASCII command - B=
Data list - XXX.X

COMMAND DEFINITION: Instructs T-1401 selected bearing to be fixed at XXX.X degrees.

DATA LIST DEFINITION: Maximum of five characters are output with a range of 0 to 359.9 degrees.

EXAMPLE: "AX1=B=350.5" instructs the T-1401 to generate a bearing of 350.5 degrees.

ERROR CONDITION: Data value out of range.

ERROR CONDITION RESPONSE: Defaults to 0 degrees

(k) ---------- COMMAND: B? ----------

INSTRUCTION FORMAT:
ASCII command - B?
Data list - (XXX.X)

COMMAND DEFINITION: Samples and measure the actual bearing and transfer this value.

DATA LIST DEFINITION: Data input from T-1401 in response to the "B?" command consists of 5 characters.

EXAMPLE: AX1= B?"

ERROR CONDITION: N/A

ERROR CONDITION RESPONSE: N/A

(l) ---------- COMMAND: BR=+/-XX ----------

INSTRUCTION FORMAT:
ASCII command - BR=
Data list - +/-XX.0

COMMAND DEFINITION: Sets the Bearing Rate to +/-XX degrees per second. This command puts the T-1401 in speed mode and operates with the "DF=+/-X.X" command.

The T-1401 does not allow both speed mode and Delta Freq. mode at the same time, thus if the T-1401 is in Delta Freq. mode prior to the "BR=+/-XX" command, the unit will leave Delta Freq. mode and enter speed mode. Speed mode can be stopped by programming the bearing rate to zero degrees/sec.

DATA LIST DEFINITION: Outputs a maximum of 5 decimal ASCII characters from -39 to +39 degrees/second.

EXAMPLE: Character string "AX1=BR=+25" will ignore prior "D+/-X.X" command, set T-1401 to speed mode, and program Bearing Rate generator for 25 degrees/second.

The commands "AX1=BR=0" or "AX1=BR=" tells the T-1401 to exit speed mode and stop the bearing rate generator.

ERROR CONDITION: Data value out of range.

ERROR CONDITION RESPONSE: If the bearing rate programmed is less than the minimum allowed data range, the T-1401 defaults to the lower bearing rate limit of -39. If the bearing rate programmed is greater than the maximum allowed data range, the T-1401 defaults to the upper bearing rate limit of +39.

(m) ---------- COMMAND: DF=+/-X.X ----------

INSTRUCTION FORMAT:
ASCII commands - DF=
Data list - +/-X.X

COMMAND DEFINITION: Instructs the T-1401 to vary the 15 Hz and 135 Hz frequency +/-X.X percent. Upon the T-1401 accepting this command, the unit is placed in the Delta Freq. mode. Hardware limitations will not allow the unit to be in Delta Freq. mode and speed mode at the same time. Thus the unit will go from speed mode to Delta Freq. mode.

DATA LIST DEFINITION: Outputs a maximum of four (4) decimal ASCII characters from -3.9 to +3.9 percent. If no value follows the command ("DF=" or "DF=0"), then the unit will leave the Delta Freq. mode, thus clearing any previously stored data.

EXAMPLE: ASCII character string "AX1=DF=1.0" instructs the T-1401 t select Delta Freq. and alter the 15 Hz and 135 Hz signals 1 percent.

ASCII character string "AX1= or DF=0" instructs the T-1401 to leave Delta Freq. mode and ignore any previously stored values for delta frequency.

ERROR CONDITION: Data value Lower limit (-3.9)
Data Upper limit (+3.9)

ERROR CONDITION RESPONSE: If the delta frequency is programmed with a value less than the minimum allowed lower limit, then the T-1401 will instruct a delta frequency value equal to the lower range. If the delta frequency is programmed with a value greater than the maximum allowed upper limit, the T-1401 will instruct a delta frequency value equal to the upper range.

(n) ---------- COMMAND: GA ----------

INSTRUCTION FORMAT:
ASCII command - GA
Data list - None

COMMAND DEFINITION: Select T-1401 Ground-to-Air TACAN mode. The T-1401 has four (4) possible TACAN modes of operation; Ground-to-Air, Air-to-Air, and Inverse G/A and Inverse A/A, (GA, AA, INVGA, INVAA respectfully). Only one TACAN mode can be active at any given time.

DATA LIST DEFINITION: No input/output data.

EXAMPLE: ASCII character string "AX1=GA" sets the T-1401 in Ground to Air TACAN mode.

ERROR CONDITION: N/A

ERROR CONDITION RESPONSE: N/A

(o) ---------- COMMAND: INVGA ----------

INSTRUCTION FORMAT:
ASCII command - INVGA
Data list - None

COMMAND DEFINITION: Selects T-1401 Inverse G/A TACAN mode of operation. The T-1401 has four (4) possible TACAN modes of operation; Ground-to-Air, Air-to-Air, Inverse G/A and Inverse A/A, (GA, AA, INVGA, INVAA commands respectively). Only one TACAN mode of operation can occur at any given time.

DATA LIST DEFINITION: No input/output data.

EXAMPLE: ASCII character string "AX1= INVGA" will instruct the T-1401 to select Inverse G/A TACAN mode of operation.

ERROR CONDITION: N/A

ERROR CONDITION RESPONSE: N/A

(p) ---------- COMMAND: INVAA ----------

INSTRUCTION FORMAT:
ASCII Command - INVAA
Data List - None

COMMAND DEFINITION: Selects T-1401 Inverse A/A TACAN mode of operation. The T-1401 has four (4) possible TACAN modes of operation; Ground-to-Air, Air-to-Air, Inverse G/A and Inverse A/A (GA, AA, INVGA, INVAA commands respectively). Only one TACAN mode of operation can occur at any given time.

DATA LIST DEFINITION: No input/output data.

EXAMPLE: ASCII character string "AX1=INVAA" will instruct the T-1401 to select Inverse A/A TACAN mode of operation.

ERROR CONDITION: N/A

ERROR CONDITION RESPONSE: N/A

(q) ---------- COMMAND: M=+/-X.X ----------

INSTRUCTION FORMAT:
ASCII command - M=
Data list - +/-X.X

COMMAND DEFINITION: Instructs the T-1401 to set the Main Reference Bursts' reference deviation setting to +/=X.X Microseconds. This command works in conjunction with the "MØ" and "M1" commands.

DATA LIST DEFINITION: A maximum of four (4) decimal ASCII commands including the decimal point are output to the T-1401, with a range of -3.9 to +3.9 microseconds.

EXAMPLE: ASCII character string "AX1=M=2.5" instructs the T-1401 to deviate the MRB's +2.5 μs from the nominal value. ASCII command "AX1= M=" will cause the T-1401 to reset back to the nominal value.

ERROR CONDITION: Data value out of range.

ERROR CONDITION RESPONSE: Defaults to negative minimum limit if data value is under range and defaults to positive maximum range if data value is over range.

(r) ---------- COMMAND: MØ ----------

INSTRUCTION FORMAT:
ASCII command - MØ
Data list - None

COMMAND DEFINITION: Instructs the T-1401 to select Main Reference Bursts to an OFF state.

DATA LIST DEFINITION: No input/output data

EXAMPLE: ASCII character string "AX1= MØ" turns off the Main Reference Bursts.

ERROR CONDITION: N/A

ERROR CONDITION RESPONSE: N/A

(s) ---------- COMMAND: M1 ----------

INSTRUCTION FORMAT:
ASCII command - M1
Data list - None

COMMAND DEFINITION: Instructs the T-1401 to set the Main Reference Bursts to an on state.

DATA LIST DEFINITION: No input/output data.

EXAMPLE: ASCII character string "AX1=M1" instructs the T-1401 to turn on the Main Reference Bursts.

ERROR CONDITION: N/A

ERROR CONDITION RESPONSE: N/A

(t) ---------- COMMAND: MDP=+/-X ----------

INSTRUCTION FORMAT:
ASCII command - MDP=
Data list - +/-X

COMMAND DEFINITION: Instructs T-1401 to set the Main Reference Bursts pulse (or pulse pair) quantities to +/-X for the nominal amount.

DATA LIST DEFINITION:

EXAMPLE: ASCII character string "AX1= MDP=Z" instructs the T-1401 to add 2 pulses (or pulse pairs) to the Main Reference Bursts.

ERROR CONDITION: Data value out or range.

ERROR CONDITION RESPONSE: Defaults to zero.

(u) ---------- COMMAND: MOD15=XX ----------

INSTRUCTION FORMAT:
ASCII command - MOD15=
Data list - XX

COMMAND DEFINITION: Instructs T-1401 to modify the 15 Hz component of the composite signal by a percentage.

DATA LIST DEFINITION: A maximum of two (2) decimal ASCII characters, with a range of 0% to 39%.

EXAMPLE: ASCII character string "AX1= MOD15=25" instructs the unit to modify the 15 Hz component to 25%. ASCII character string "AX1= MOD15=" or "AX1= MOD15=Ø" will turn the 15 Hz component OFF.

ERROR CONDITION: Data value out of range.

ERROR CONDITION RESPONSE: Value defaults to maximum.

(v) ---------- COMMAND: MOD135=XX ----------

INSTRUCTION FORMAT:
ASCII command - MOD135=
Data list - XX

COMMAND DEFINITION: Instructs T-1401 to modify the 135 Hz component of the composite signal by a percentage.

DATA LIST DEFINITION: A maximum of two (2) decimal ASCII characters, with a range of 0% to 39%.

EXAMPLE: ASCII character string "AX1= MOD135=25" instructs the unit to modify the 135 Hz component to 25%. ASCII character string "AX1= MOD135=" or "AX1= MOD135=Ø" will turn the 135 Hz component signal OFF.

ERROR CONDITION: Data value out of range.

ERROR CONDITION RESPONSE: Value defaults to maximum.

(w) ---------- COMMAND: PH=+/-XX ----------

INSTRUCTION FORMAT:
ASCII command - PH=
Data list - +/-XX

COMMAND DEFINITION: Instructs the T-1401 to select the phase shift between 15 Hz and 135 Hz sinusoids between -XX degrees and +XX degrees.

DATA LIST DEFINITION: Outputs a maximum of three (3) decimal ASCII digits between -39 degrees and +39 degrees.

EXAMPLE: ASCII character string "AX1= PH=32" instructs the T-1401 to select a phase shift of 32 degrees.

ERROR CONDITION: Data value out of range.

ERROR CONDITION RESPONSE: Value defaults to zero (Ø).

(x) ---------- COMMAND: DISPB. ----------

INSTRUCTION FORMAT:
ASCII command - DISPB.
Data list - None

COMMAND DEFINITION: Instructs the T-1401 to display measured bearing. T-1401 generates bearing and bearing rate regardless whether or not bearing is displayed.

DATA LIST DEFINITION: N/A

EXAMPLE: ASCII character string "AX1-DISPB." instructs the T-1401 to display measured bearing.

ERROR CONDITION: N/A

ERROR CONDITION RESPONSE: N/A

(y) ---------- COMMAND: DISPRD. ----------

INSTRUCTION FORMAT:
ASCII command - DISPRD.
Data list - None

COMMAND DEFINITION: Instructs the T-1401 to display measured reply delay in μs. T-1401 measure reply delay regardless whether or not it is displayed.

DATA LIST DEFINITION: N/A

EXAMPLE: ASCII character string "AX1-DISPRD." instructs the T-1401 to display measured reply delay.

ERROR CONDITION: If reply delay is out of tolerance, an "F" will precede reply delay reading. If reply delay is 89 μs, or A/A mode is not selected, "DDD.D" will be displayed.

ERROR CONDITION RESPONSE: None

(z) ---------- COMMAND: RD? ----------

INSTRUCTION FORMAT:
ASCII command - RD?
Data list - None

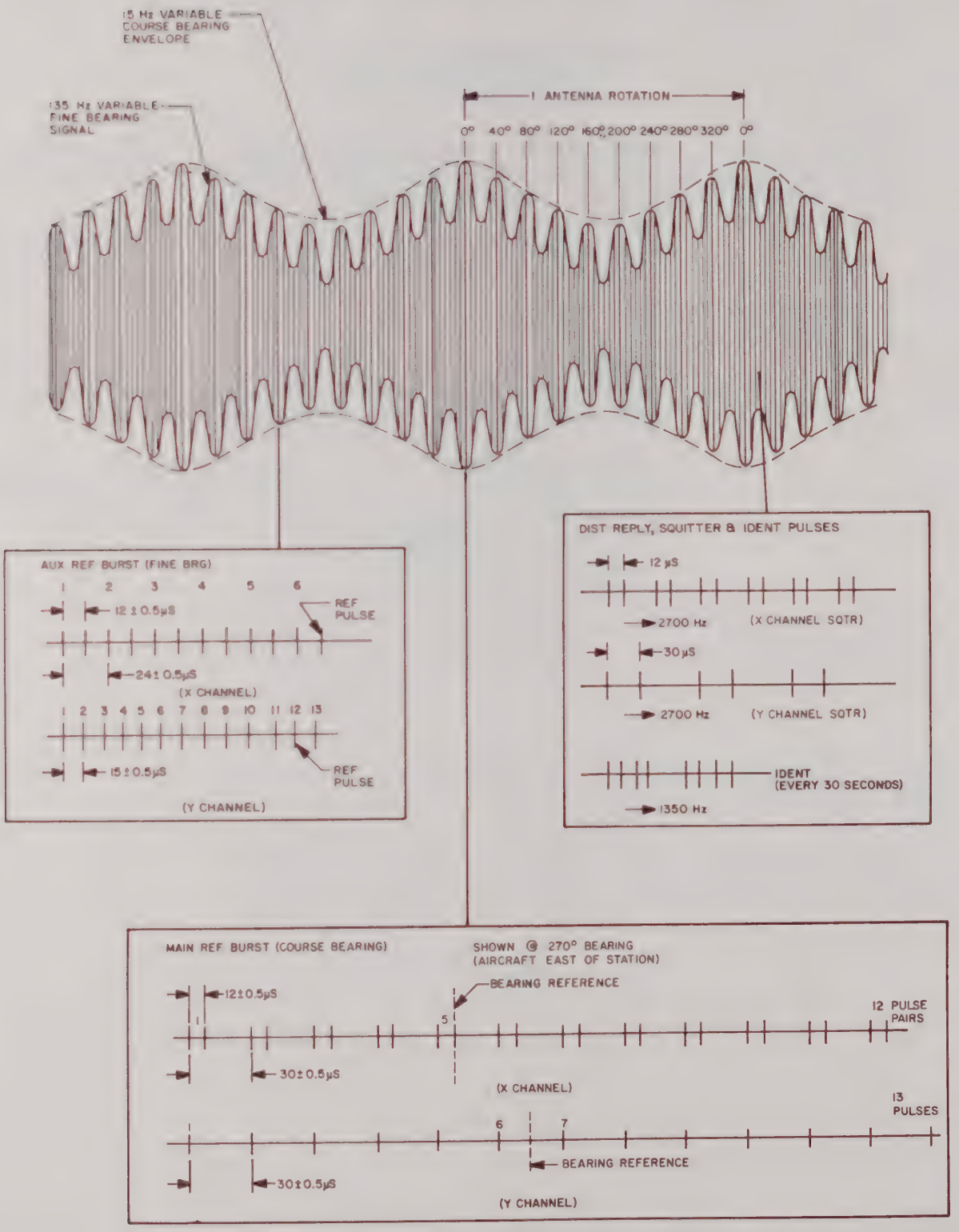
COMMAND DEFINITION: Instructs the T-1401 to get measured reply delay in μs and return the value when the ATC-1400A is addressed to talk.

DATA LIST DEFINITION: Data input from the T-1401 in response to the "RD?" command consists of up to five ASCII characters including the decimal point with a range of 0.1 to 89.9 μs.

EXAMPLE: ASCII character string "AX1=RD?" instructs the T-1401 to get reply delay measurement and return value when ATC-1400A is addressed to talk.

ERROR CONDITION: If reply delay is out of tolerance, an "F" will precede reply delay reading. If reply delay is >89.9 μs, or A/A mode is not selected, "DDDD" will be returned.

ERROR CONDITION RESPONSE: None



Surface Beacon Transmit Signal
Figure 14

6. Error Codes

The error codes which may appear on the T-1401 BEARING/REPLY DELAY Display (4) are defined as follows:

EC01 Invalid bearing rate. The operator has selected a bearing rate outside of the range of 39.0 deg/sec.

EC02 Delta F mode invalid. The operator has selected non-zero frequency deviation during a non-zero bearing rate.

EC03 Bearing rate mode invalid. The operator has selected non-zero bearing rate during a non-zero frequency deviation.

DDD.D Invalid Reply Delay (when DISPLAY SELECT Switch [5] is in REPLY DELAY position). The Reply Delay reading is >89.9 μs, or A/A mode is not selected.

The following error code may occur only when the T-1401 is connected to an ATC-1400A via the IFR bus.

EC04 RF frequency mode selection is invalid. The operator has selected a VOR frequency pair on the ATC-1400A when in the A/A or INV A/A Mode. The operator has selected a VOR frequency pair on the ATC-1400A when in the A/A or INV A/A Mode.

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2. TACAN TEST SYSTEM SPECIFICATIONS

These specifications supersede ATC-1400A and T-1401 specifications whenever the T-1401 is mated to the ATC-1400A. Refer to Section 1-3-1 of either the ATC-1400A or T-1401 Operation/Maintenance Manual (as appropriate) for specifications not listed in this section.

A. Mode Characteristics

1. Bearing

Range:	0 to 359.9 degrees in 0.1 degree increments.
Accuracy:	G/A Mode, 135 Hz ±0.05 degrees G/A Mode, 15 Hz ±0.10 degrees A/A Mode, 15 Hz ±0.10 degrees INV Mode, 15 Hz ±0.30 degrees.

2. Bearing Rate

Range:	0 to ±39 degree(s) per second in 1 degree increments.
Accuracy:	±0.1 degree per second.

3. TACAN Modulation

Range:	0 to 39% in 1% increments. 15 Hz and 135 Hz separately adjustable.
Accuracy:	±1%
Distortion:	<2.0% of either tone.

4. 15 Hz Phase Shift

Range:	0 to ±39 degree(s) in 1 degree increments.
Accuracy:	±0.2 degree.

5. TACAN Reference Frequency

Range:	±3.9% of nominal in 0.1% steps.
Accuracy:	±0.01%

6. Main Reference Burst

Control:	Selectable ON/OFF on REFERENCE DEV MRB Thumbwheels (7).
Length:	12 pulse pairs nominal in G/A X mode;
	13 single pulses nominal in G/A Y mode;
	10 single pulses nominal in A/A X or Y mode (May be adjusted for -1, -2, +1 or +2).
Spacing:	30.0 µs nominal (May be adjusted for ±3.9 µs in 0.1 µs increments).
Accuracy:	±0.1 µs

7. Auxiliary Reference Burst

Length:	6 pulse pairs in G/A X Mode;
	13 single pulses nominal in G/A Y mode;
	Adjustable +1, +2, -1 or -2.
Spacing:	24.0 µs in G/A X mode, 15.0 µs in G/A Y mode. Adjustable ±3.9 µs in 0.1 µs increments.
Position:	The first ARB following MRB may be disabled.
Accuracy:	±0.1 µs.

8. A/A Interrogations

Average Rate:	0 to 3999 per second, selectable in 1 Hz steps.
Accuracy:	1%
Distribution:	Period is random in discrete steps. Minimum period is approx.: $\frac{1}{2 \times rate}$.
	The minimum period at any setting is 100 µs.
	Maximum period is approx.: $\frac{23}{2 \times rate}$.

9. Ident

Position:	740 ±50 µs after reference burst.
Code interval:	37 seconds (typical).

10. Pulse Characteristics (ATC-1400A)

Spacing	12.0 µs (±0.1 µs) X Channel DME and TACAN replies;
	30.0 µs (±0.1 µs) Y Channel DME and TACAN replies;
	12.0 µs (±0.1 µs) X Channel A/A TACAN interrogation;
	24.0 µs (± 0.1 µs) Y Channel A/A TACAN interrogation.

11. UUT A/A Reply Delay Measurement

Definition:	Measured from the 50% point of the leading edge of P1 of the interrogation to the 50% point of the leading edge of the reply.
Range:	25.0 to 89.9 µs in 0.1 µs steps.
Accuracy:	±0.1 µs.
Decoder Window position:	X Channel centered at 62.0 µs. Y Channel centered at 74.0 µs.
Accept:	<±0.5 µs
Reject:	>±1.0 µs
	If the reply delay is outside of window, an "F" will precede reply delay reading.
Error Conditions:	If no reply occurs within 89.9 µs of P1, or A/A mode is not selected, "DDD.D" will be displayed.

12. UUT Pulse Interrogation Spacing Detector

Position:	12.0 µs for X Channel G/A and A/A TACAN 24.0 µs for Y Channel A/A TACAN 36.0 µs for Y Channel G/A TACAN
Accuracy:	Measured from the 50% point of P1 to 50% point of P2.
Windows:	
Narrow:	Accept: <±0.5 µs Reject: >±1.0 µs

Wide:	Accept: <±2.0 µs Reject: >±3.0 µs

13. SCOPE SYNC

15 Hz:	27.0 µs before the positive going zero crossing of the 15 Hz sine wave modulation.
135 Hz:	2.5 µs before the positive going zero crossing of the 8th 135 Hz sine wave modulation after the 15 Hz positive going zero crossing.
MRB:	3.0 µs before the first pulse of the Main Reference Burst.
ARB:	3.0 µs before the first pulse of each Auxiliary Reference Burst.
A/A INTERR:	3.0 µs before the first pulse of each A/A Interrogation pulse pair.
INV TACAN Sync:	Leading Edge is coincident with negative going zero crossing of the 15 Hz sine wave with 180 degrees bearing selected.
Polarity:	Internally selectable, standard setting is negative.
Width:	70 µs (±18.0 µs)

14. External Interrogations

J10010 Enable:	Enables J10011, and gates off all other interrogations including reference bursts and Ident pairs as long as ENABLE is active.
Polarity:	Active low
Level:	TTL
J10011 TRIGGER:	Triggers modulator when enabled by J10010.
Polarity:	Negative edge
Level:	TTL

B. Power Characteristics

AC Input:	105 to 120 VAC or 210 to 250 VAC, 50 to 400 Hz, power consumption is less than 150 watts.

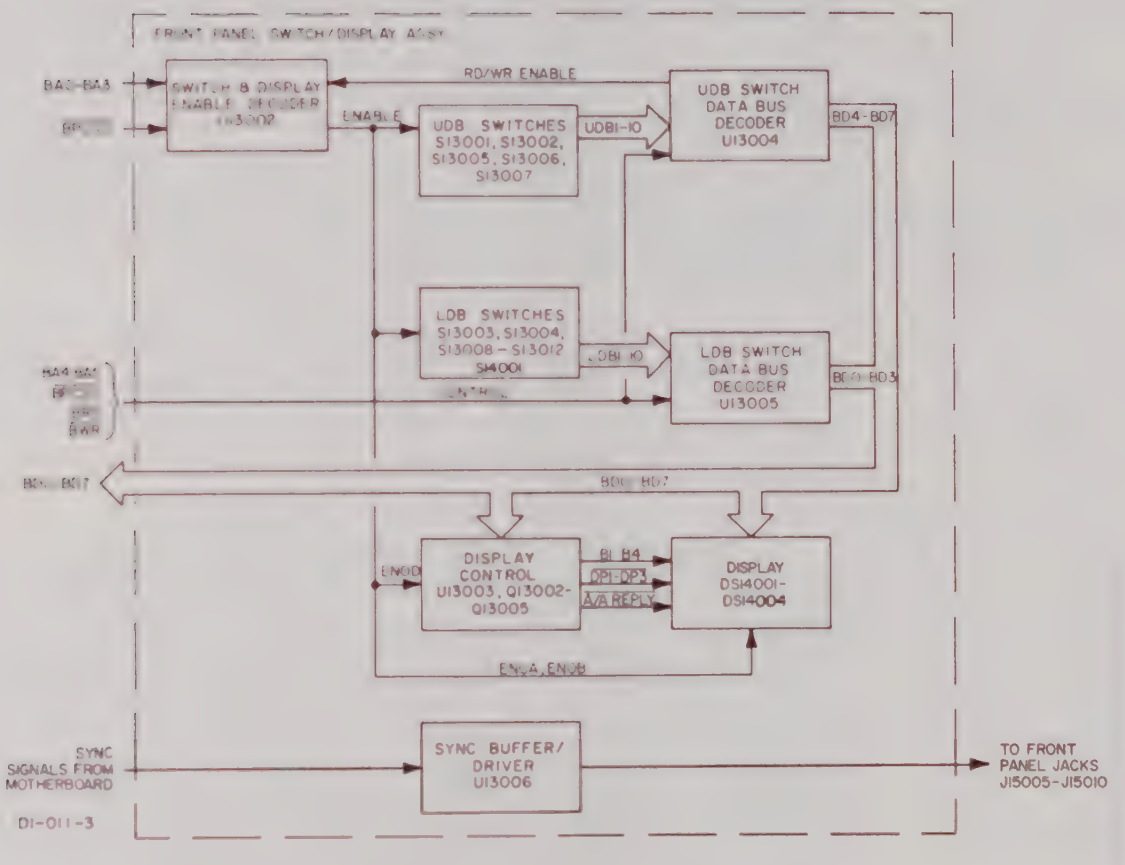
The IFR interface port is activated when IFR port address lines A0 through A3 are set to match the AUXSEL address line jumpered at the output of communications controller decoder U12005. A matching address received from the IFR port sets AUXSEL active low. The AUXEL signal is gated with IFR port RD and INTR signals to enable and set the direction of signal flow through communications controller data transceiver U12004. Data is exchanged over IFR D0-D7 bus through data transceiver U12004 and 8-bit bi-directional port P20-P27 of MUART U12003. Handshake control between the IFR port and MUART U12003 is maintained with P10 (INTA), P11 (INTR), P15 (AUXSEL), P16 (RD), P17 (WR), and EXTINT.

Data is exchanged between the RS232 port and MUART U12003 through RS232 interface U12022. RS232 interface U12022 is a signal level translater that matches the RS232 levels (±30 volt input, ±9 volt output) to those of the MUART (TTL). MUART U12003 converts parallel data from the AD bus to serial format. The RS232 signal CTS is used to maintain handshake control.

(3) Front Panel Assembly. See figures 5 and 16 (sheets 2 and 3). The Switch PC Board allows the operator to control the output of the T-1401. The thumbwheel switches have decimal coded outputs which means that only one switch output is connected to the switch common at any given position. The outputs of the switches are wired in parallel on the Switch PC Board to form the Upper Decimal Bus (UDB) and the Lower Decimal Bus (LDB). The Switches are read periodically by the Computer PC Board in the following manner. First UDB and LDB bus decoders U13004 and U13005 are enabled by an active low BPSCO and are addressed by BA1, and BA5. At the same time, the address of the switch or switches to be read is asserted on switch address and display enable decoder U13002.

Next, the Computer PC Board sets BRD active low, enabling UDB and LDB bus decoders U13004 and U13005 to write data from the switch decimal bus(es) onto buffered data bus BD0-BD7. Also, UDB bus decoder U13004 enables switch and display enable decoder U13002 to set the selected switch enable line active low. Switch settings are translated into an active low on the associated upper or lower switch decimal bus, as the active low switch select line pulls the switch wiper and connected contacts to active low. Diodes on the switch wiper contacts provide isolation between the outputs of switch and display enable decoder U13002. The outputs of switch and display enable decoder U13002 that are not selected float at open-collector potential, so as not to effect the selected switches.

Finally, UDB and LDB bus decoders U13004 and U13005 convert upper decimal bus UDB1-UDB10 and lower decimal bus LDB1-LDB10 from ten



Front Panel Assembly, Block Diagram
Figure 5

bits to four bits. The four-bit outputs from the decimal bus decoders are read by the Computer PC Board via buffered data bus BD0-BD7.

Data is written to the Display PC Board from the Computer PC Board following a sequence similar to that used in reading the thumbwheel switches. First, upper and lower decimal bus UDB and LDB decoders U13004 and U13005 are enabled by an active low BPCS0 and are addressed by BA4 and BA5. The address of display control U13003 or one of two display enable lines is simultaneously loaded into swith and display enable decoder U13002.

Next, the Computer PC Board sets $\overline{\text{BWR}}$ active low. The active low BWR gates through the decimal bus decoders and then enables switch

and display enable decoder U13002 to set the selected enable line active low. When the enable signal reaches display control U13003 or display DS14001-DS14005, the data on BD0-BD7 is read by the enabled circuits.

Display control U13003 latches data from BD0-BD7 on the rising edge of the active low enable signal. Bits BD0-BD3 are latched and sent to display devices DS14001-DS14004 as blanking signals B1-B4. The blanking signal turns off the associated display when set active high. Bits BD4, BD6, and BD7 are inverted by transistors Q13005. Q13003 and Q13002, respectively, to become active low, right-hand decimal point control signals for DS14003, DS14002, and DS14001. The remaining bit BD5; is not used. Display devices DS14001-DS14004 latch four bits of data from BD0-SD7 on the falling edge of the associated enable signal. The display device converts the four-bit data data input into the display seven-segment data output. Sync buffer/driver U13006 provides a buffer between the Motherboard and Front Panel Assembly connectors J15005-J15010.

(4) Analog PC Board. See figures 6 and 17 (sheets 2 and 3). The Analog PC Board sends and receives data to the Computer PC Board (via the Motherboard PC Board) using the address and data buses.

(a) Address bus lines A3, A4 and A5 are applied to a 3-to-8 line decoder U21024. Resistor network RN21002 is a pull-up resistor for each of the address lines. The active low WR and RD signals are combined in U21019D and applied to the active high enable input of U21024. This signal goes active high whenever the $\overline{WR}$ or $\overline{RD}$ is active low. The active low BPCS2 signal is applied to the active low enable input of U21024.

When both enable inputs are active, decoder U21024 develops the chip select signals for the Analog PC Board. These signals determine which portion of the data bus, D0-D7, will be loaded into various circuits throughout the Analog PC Board. See figure 17 (sheets 2 and 3).

(b) Multivibrator U21001B and associated components form a 3.888 MHz oscillator. This is the reference signal from which the 15 Hz and 135 Hz timing is generated during normal operation. Crystal Y21001 and capacitor C21001 sustain the oscillations. Resistor R21003 is used to adjust the output frequency. The 3.888 MHz is applied to NAND gate U21004A. The circuit formed by U21004A, U21004B, U21004C and U21004D forms a selector switch which is controlled by the active low $\overline{EXT\ FREQ}$ signal

out of octal latch U21015. In normal operation, the $\overline{\text{EXT FREQ}}$ signal is high which gates the 3.888 MHz clock signal from U21001 to the divide by two flip-flop U21003A. When in the external frequency mode of operation, the EXT FREQ signal is active low which gates an external clock signal applies through J21003 to U2103A as the reference signal in place of the signal from U21001B.

The 1.944 MHz square wave is applied to phase lock loop U21002 and erasable programmable logic device U21023.

(c) A complete phase lock loop is formed by U21001A, U21001B, U21003A, U21002, U21005 and associated components. When a bearing rate or delta frequency other than zero has been entered by the operator, the phase lock loop generates a clock signal that is slightly higher or lower in frequency than the 3.888 MHz reference. The information for the new frequency is loaded into U21002 on the rising edge of active low CS2 signal from U21024. It is loaded four bits at a time from data bus D0-D3 and is stored in the appropriate location in U21002 as directed by address bus A0-A2. Phase-lock-loop U21002 compares the frequency out of flip-flop U21003A with the frequency out of voltage controlled multivibrator J21001A to generate an error signal. Operational amplifier U21005 and associated components filter the error signal and develop the frequency control signal for voltage-controlled multivibrator U21001A. Capacitor C21002 determines the center frequency of U21001A. Flip-flop U21003B divides the output of U21001A by two. The signal at test point TP21002 is the 1.944 MHz VCM frequency. This signal is applied to erasable progammable logic device U21023.

(d) The data bus is applied to octal latches U21015 and U21016. The data is loaded into U21015 by the active low CS3 signal and into U21016 by the active low CS4 signal. Four discrete control signals are loaded into U21015. The output of U21015, pin 19, is the $\overline{\text{EXT FREQ}}$ signal, and it is applied to NAND gates U21004A and B to select either the 3.888 MHz signal from U21013 or the EXT FREQ from J21003. The output of U21015 pin 18 is the active high DELTA FREQ signal, and it is applied to pin 18 of U21023. The DELTA FREQ signal will be high whenever the operator has selected a non-zero delta frequency. The output of U21015, pin 17, is applied to counter U21013. This is the Most Significant Bit (MSB) of the 15 Hz to 135 Hz phase counter. The active high V signal out of U21015, pin 16, is applied to erasable programmable logic device U21021 pin 3. The V signal will be high whenever the operator has selected a non-zero bearing rate. The remaining

(j) The data bus is loaded into octal latch U21027 at the rising edge of the active low CS1 signal. This data is applied to digital-to-analog converter U21036. These signals are the percent of modulation of the 135 Hz. DAC U21036 converts this data to an analog signal. Resistor R21013 adjusts the amplitude of the output of U21036. Operational amplifier U21040, and its associated components, amplify the analog percent of modulation signal and provide isolation. The output of U21040 is applied to the reference input of DAC U21035. A portion of the output is applied to feedback input of U21036.

(k) The circuit formed by U21046, U21032, U21029B, U21029C, U2109D, U21030D, U21028, U21035, U21042 and associated components convert the AUD CK A4 signal into a 135 Hz sine wave. The amplitude of the sine wave is controlled by U21027, U21036, U21040 and associated components.

Erasable programmable logic device U21046 is a counter and its associated logic generates a signal that counts from zero to nine hundred and back to zero for each one-half cycle of the 135 Hz sine wave. The AUD CK A4 signal is applied to U21046 and is the clock input to the internal counter. Output data is latched on the rising edge of the AUD CK A2 signal which is applied to U21046 and U21028. The zero degree signal out of pin 22 of U21046 is inverted by NAND gate U21029C, and may be monitored at test point TP21013. This SYNC CLK signal is a 270 Hz pulse train which occurs at each zero crossing of the 135 Hz sine wave. It is applied to NAND gate U21029D. The A10 signal at pin 17 of U21046 is inverted by U21029B, and applied to U21032 and U21029D. NAND gate U21029D combines the A10 and SYNC CLK signal to form the TOP Ø signal. The TOP Ø signal is a 135 Hz pulse train with 2 microsecond pulses that occur at the positive-going zero crossing of the 135 Hz sine wave. It may be monitored at test point TP21011. The counter outputs of U21046 are applied to erasable PROM U21032. The output of U21032 is applied to octal latch U21028. The signals are loaded into U21028 by the AUD CLK A2 signal. The output of U21028 is the digitized sine wave signal, and is applied to DAC U21035.

(l) The output of DAC U21035 is the 135 Hz sine wave signal. Operational amplifiers U21042, U21043B, and associated components, amplify the 135 Hz sine wave signal. A portion of the output of U21042B is applied to the feedback input of U21035. It is also applied to operational amplifier U21044. The 135 Hz MOD signal may be monitored at test point TP21017, and is applied to pin C2 of P21001.

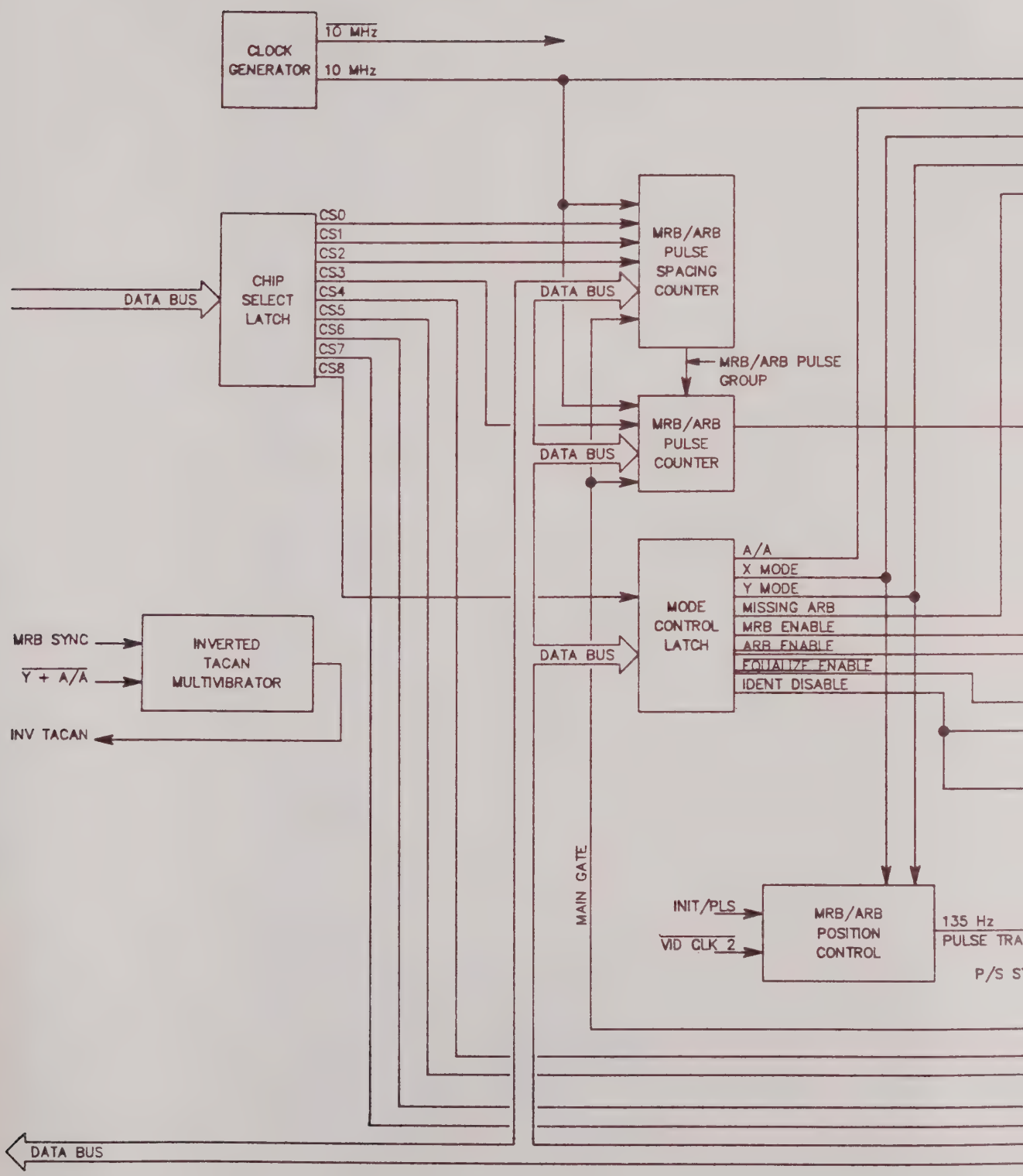
(m) The circuit formed by U21045, U21031, U21019A, U21030B, U21026, U21033, U21041 and associated components convert the AUD CK B4 signal into a 15 Hz sine wave. The amplitude of the sine wave is controlled by U21015, U21034, U21039 and associated components. The operation of these circuits is identical to those that generate the 135 Hz sine wave. The INIT 15 Hz signal from U21006 forces the U21045 internal counter to zero to establish the 15 Hz positive-going zero crossing at the desired time.

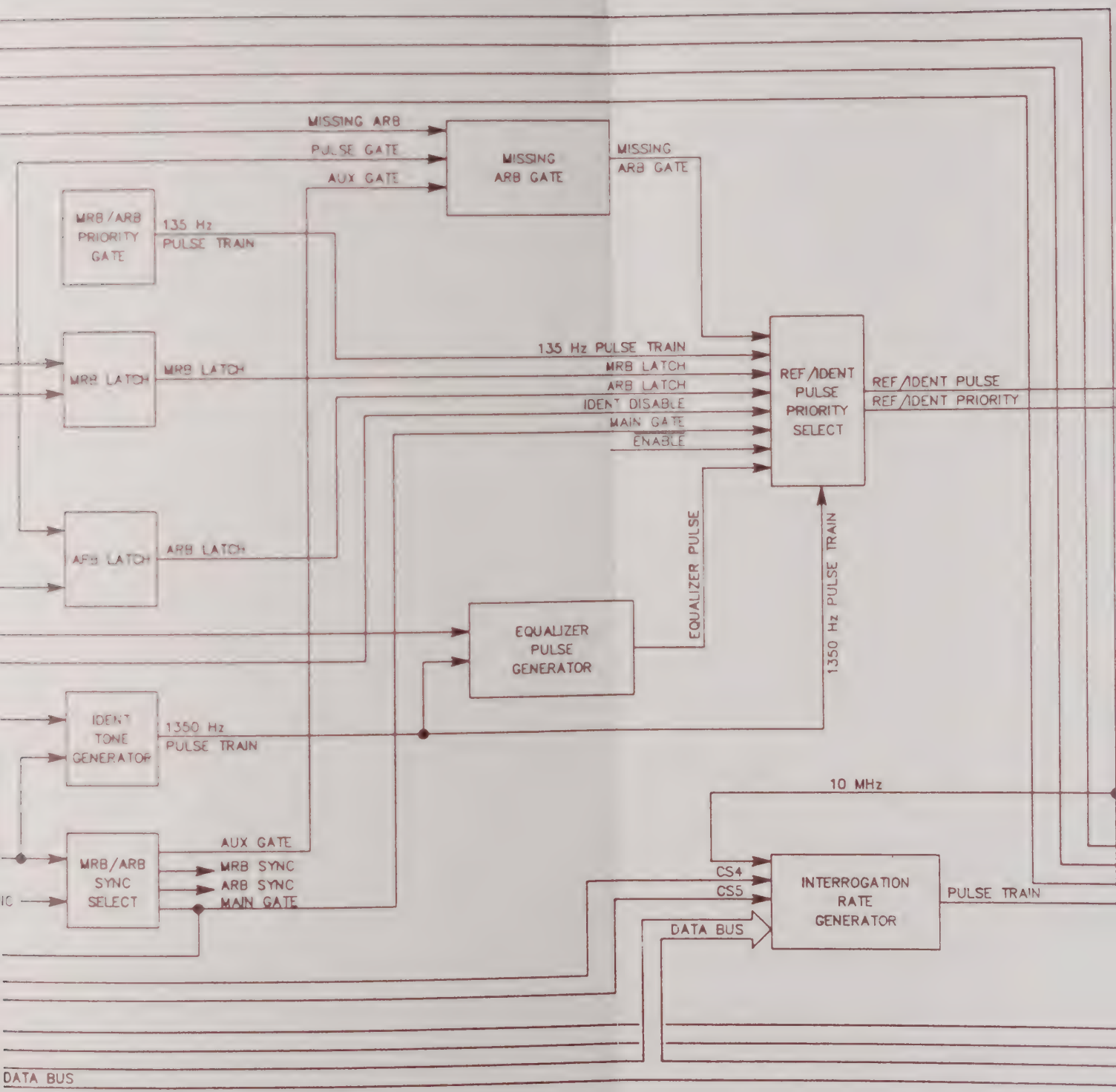
(5) TACAN PC Board. See figures 7 and 18 (sheets 2 and 3). The TACAN PC Board generates the Main and Auxiliary Reference Bursts, identification and Equalizer pulse pairs and A/A interrogation pulse pairs. The TACAN PC Board also generates the priority signals for all of the pulses. The priority signals are used by the ATC-1400A to establish which pulses (reference burst, identification, A/A interrogation, distance reply or squitter) are to be transmitted at any given time. In addition, the A/A Reply Delay measurement and INV TACAN sync output circuit are also on the TACAN PC Board.

(a) The TACAN PC Board receives data from the Computer PC Board (via the Motherboard PC Board) using the address and data buses. Address bus lines A0, A1, A2 and A3 are applied to 3-to-8 line decorders U11057 and U11058. Resistor network RN11002 is a pull-up resistor for each of the address lines. The active low WR signal is applied to the active low enable input of U11057 and U11058. The active low BPCS2 signal is applied to the other active low enable input of U11057 and U11058. When both enable inputs are active, decoders U11057 and U11058 develop the chip select signals for the TACAN PC Board. These signals determine which portion of the data bus, D0-D7, will be loaded into various circuits throughout the TACAN PC Board.

(b) Multivibrator U11001 and its associated components are a 10 MHz oscillator, Crystal Y11001, C11026, and R11001 and R11002 determine the frequency of the multivibrator. The frequency of the multivibrator may be adjusted by R11001. Inverter U11002A inverts the 10 MHz and buffers the multivibrator. The 10 MHz may be monitored at test point TP11001. The 10 MHz is used throughout the TACAN PC Board for timing.

(c) The Ø CROSS signal at connector P11001 pin A19 is a 15 Hz pulse train signal that occurs at the negative-going zero crossing fot the 15 Hz sine wave, and is applied to multivibrator U11056A pin 2. The Ø CROSS signal may be monitored at test point TP11028. Capacitor C11003 and resistor R11005 determine the time of the multivibrator action. The output of U11056A is a 15 Hz pulse train with


CLOCK GENERATOR
10 MHz
10 MHz
CHIP SELECT LATCH
DATA BUS
CS0
CS1
CS2
CS3
CS4
CS5
CS6
CS7
CS8
MRB/ARB PULSE SPACING COUNTER
DATA BUS
MRB/ARB PULSE GROUP
MRB/ARB PULSE COUNTER
DATA BUS
MODE CONTROL LATCH
DATA BUS
A/A
X MODE
Y MODE
MISSING ARB
MRB ENABLE
ARB ENABLE
EQUALIZE ENABLE
IDENT DISABLE
MRB SYNC
Y + A/A
INVERTED TACAN MULTIVIBRATOR
INV TACAN
MAIN GATE
INIT/PLS
VID CLK 2
MRB/ARB POSITION CONTROL
135 Hz
PULSE TRA
P/S S
DATA BUS

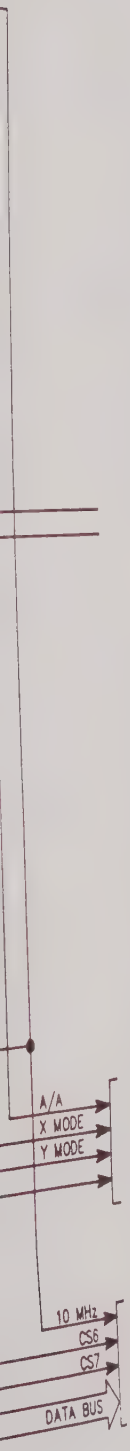

MISSING ARB
PULSE GATE
AUX GATE
MISSING ARB GATE
MISSING ARB GATE
MRB/ARB PRIORITY GATE
135 Hz PULSE TRAIN
MRB LATCH
MRB LATCH
135 Hz PULSE TRAIN
MRB LATCH
ARB LATCH
IDENT DISABLE
MAIN GATE ENABLE
REF/IDENT PULSE PRIORITY SELECT
REF/IDENT PULSE
REF/IDENT PRIORITY
ARB LATCH
ARB LATCH
EQUALIZER PULSE
1350 Hz PULSE TRAIN
EQUALIZER PULSE GENERATOR
IDENT TONE GENERATOR
1350 Hz PULSE TRAIN
10 MHz
AUX GATE
MRB/ARB SYNC SELECT
MRB SYNC
ARB SYNC
MAIN GATE
CS4
CS5
DATA BUS
INTERROGATION RATE GENERATOR
PULSE TRAIN
DATA BUS

(i) Flip-Flop U11026B, counters U11022 and U11023 and associated circuitry control the timing of the identification and equalizer pulses. The counters are loaded when the reference burst priority signal is coupled through U11018B, U11021B and U11021D and clocks flip-flop U11026B. The counters are allowed to begin counting when the delayed INIT/PLS signal is coupled through U11020B and U11021C and clears flip-flop U11026B. The 54 kHz VID CLK 2 at connector P11001 pin B3 is also applied to the clock inputs of counters U11022 and U11023. Counters U11022, U11023, and associated gates form the identification tone generator. The output of AND gate U11034B is a 1350 Hz pulse train that is delayed by 740 microseconds from the 135 Hz pulse train signal at test point TP11003. This signal may be monitored at test point TP11011. The 1350 Hz pulse train is applied to multivibrator U11029A and OR gate U11018C. The 1350 Hz pulse train is delayed 100 microseconds through multivibrators U11029A and U11029B. The resultant output of OR gate U11018C is two pulses separated by 100 microseconds. This signal may be monitored at test point TP11012. The output of U11026B is also the identification and equalizer priority signal and may be monitored at TP11010.

(j) Flip-flop U11030A is clocked by the output of counter U11015. The D input for U11030A is the MRB ENABLE signal from flip-flop U11028. The output from U11030A is the MRB latch signal and is applied to AND gate U11017B pin 4. Flip-flop U11030B is clocked by the output of counter U11015. The D input for U11030B is the ARB ENABLE signal from flip-flop U11028. The output from U11030B is the ARB latch signal and is applied to AND gate U11017C pin 9.

(k) The 135 Hz pulse train from NAND gate U11019D is applied to NOR gates U11003B and U11003C. NOR gate U11003B is gated on by the MAIN gate signal from flip-flop U11027B. The output of U11003B is the MRB SYNC signal. It is buffered by U11035C and applied to connector P11001 pin C4. NOR gate U11003C is gated on by the AUX gate signal from flip-flop U11027B. The output of U11003C is the ARB SYNC signal. It is buffered by U11035D and applied to connector P11001 pin C7.

(l) The output of multivibrator U11056B is also applied to flip-flop U11016A as a clock signal. During the generation of the Main reference burst, U11016A is held reset by the AUX signal from U11027B. After completion of the following Aux reference burst, U11016A is clocked by U11056B. The output of U11016A is gated through NAND gate U11033B by the MISSING ARB signal from flip-flop U11028. The MISSING ARB signal is also inverted by NAND gate U11033D and gates the AUX gate signal through NAND gate U11033A. These two gated signals are



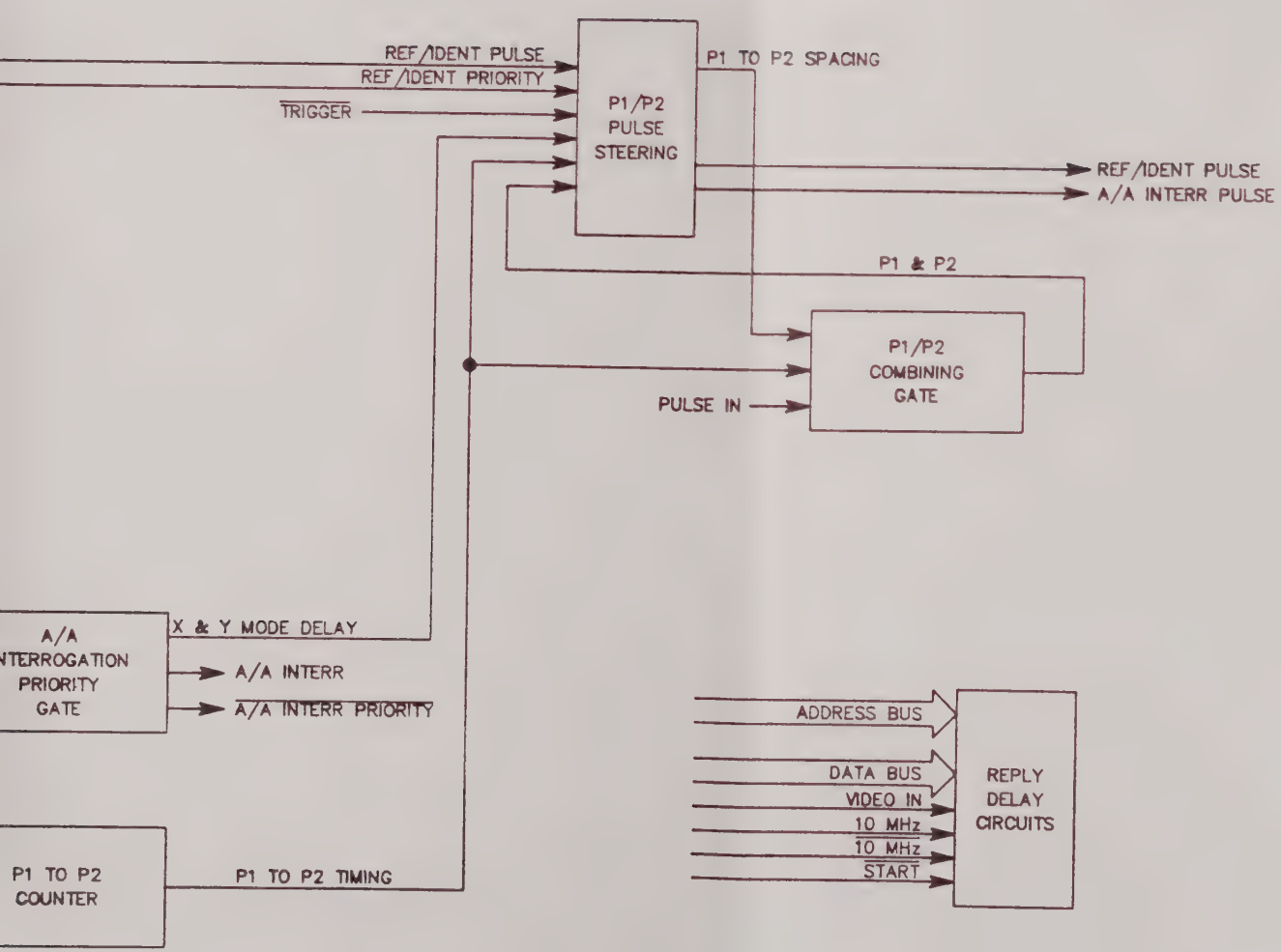
(m) The circuit formed by U21045, U21031, U21019A, U21030B, U21026, U21033, U21041 and associated components convert the AUD CK B4 signal into a 15 Hz sine wave. The amplitude of the sine wave is controlled by U21015, U21034, U21039 and associated components. The operation of these circuits is identical to those that generate the 135 Hz sine wave. The INIT 15 Hz signal from U21006 forces the U21045 internal counter to zero to establish the 15 Hz positive-going zero crossing at the desired time.

(5) TACAN PC Board. See figures 7 and 18 (sheets 2 and 3). The TACAN PC Board generates the Main and Auxiliary Reference Bursts, identification and Equalizer pulse pairs and A/A interrogation pulse pairs. The TACAN PC Board also generates the priority signals for all of the pulses. The priority signals are used by the ATC-1400A to establish which pulses (reference burst, identification, A/A interrogation, distance reply or squitter) are to be transmitted at any given time. In addition, the A/A Reply Delay measurement and INV TACAN sync output circuit are also on the TACAN PC Board.

(a) The TACAN PC Board receives data from the Computer PC Board (via the Motherboard PC Board) using the address and data buses. Address bus lines A0, A1, A2 and A3 are applied to 3-to-8 line decorders U11057 and U11058. Resistor network RN11002 is a pull-up resistor for each of the address lines. The active low WR signal is applied to the active low enable input of U11057 and U11058. The active low BPCS2 signal is applied to the other active low enable input of U11057 and U11058. When both enable inputs are active, decoders U11057 and U11058 develop the chip select signals for the TACAN PC Board. These signals determine which portion of the data bus, D0-D7, will be loaded into various circuits throughout the TACAN PC Board.

(b) Multivibrator U11001 and its associated components are a 10 MHz oscillator, Crystal Y11001, C11026, and R11001 and R11002 determine the frequency of the multivibrator. The frequency of the multivibrator may be adjusted by R11001. Inverter U11002A inverts the 10 MHz and buffers the multivibrator. The 10 MHz may be monitored at test point TP11001. The 10 MHz is used throughout the TACAN PC Board for timing.

(c) The Ø CROSS signal at connector P11001 pin A19 is a 15 Hz pulse train signal that occurs at the negative-going zero crossing fot the 15 Hz sine wave, and is applied to multivibrator U11056A pin 2. The Ø CROSS signal may be monitored at test point TP11028. Capacitor C11003 and resistor R11005 determine the time of the multivibrator action. The output of U11056A is a 15 Hz pulse train with



TACAN PC Board Assembly, Block Diagram
Figure 7

(i) Flip-Flop U11026B, counters U11022 and U11023 and associated circuitry control the timing of the identification and equalizer pulses. The counters are loaded when the reference burst priority signal is coupled through U11018B, U11021B and U11021D and clocks flip-flop U11026B. The counters are allowed to begin counting when the delayed INIT/PLS signal is coupled through U11020B and U11021C and clears flip-flop U11026B. The 54 kHz VID CLK 2 at connector P11001 pin B3 is also applied to the clock inputs of counters U11022 and U11023. Counters U11022, U11023, and associated gates form the identification tone generator. The output of AND gate U11034B is a 1350 Hz pulse train that is delayed by 740 microseconds from the 135 Hz pulse train signal at test point TP11003. This signal may be monitored at test point TP11011. The 1350 Hz pulse train is applied to multivibrator U11029A and OR gate U11018C. The 1350 Hz pulse train is delayed 100 microseconds through multivibrators U11029A and U11029B. The resultant output of OR gate U11018C is two pulses separated by 100 microseconds. This signal may be monitored at test point TP11012. The output of U11026B is also the identification and equalizer priority signal and may be monitored at TP11010.

(j) Flip-flop U11030A is clocked by the output of counter U11015. The D input for U11030A is the MRB ENABLE signal from flip-flop U11028. The output from U11030A is the MRB latch signal and is applied to AND gate U11017B pin 4. Flip-flop U11030B is clocked by the output of counter U11015. The D input for U11030B is the ARB ENABLE signal from flip-flop U11028. The output from U11030B is the ARB latch signal and is applied to AND gate U11017C pin 9.

(k) The 135 Hz pulse train from NAND gate U11019D is applied to NOR gates U11003B and U11003C. NOR gate U11003B is gated on by the MAIN gate signal from flip-flop U11027B. The output of U11003B is the MRB SYNC signal. It is buffered by U11035C and applied to connector P11001 pin C4. NOR gate U11003C is gated on by the AUX gate signal from flip-flop U11027B. The output of U11003C is the ARB SYNC signal. It is buffered by U11035D and applied to connector P11001 pin C7.

(l) The output of multivibrator U11056B is also applied to flip-flop U11016A as a clock signal. During the generation of the Main reference burst, U11016A is held reset by the AUX signal from U11027B. After completion of the following Aux reference burst, U11016A is clocked by U11056B. The output of U11016A is gated through NAND gate U11033B by the MISSING ARB signal from flip-flop U11028. The MISSING ARB signal is also inverted by NAND gate U11033D and gates the AUX gate signal through NAND gate U11033A. These two gated signals are

combined in NAND gate U1103C. The ARB LATCH signal from flip-flop U11030B and the MISSING ARB signal from U11033C are combined in U11017C and are applied to U11034D as the enable signal for the reference pulse train from U11019A. In like manner, the MRB LATCH signal from U11033A and the MAIN gate signal from U11027B are combined in U11017B. The output of U11017B is applied to U11017A as the enable signal for the refrence pulse train from U11019A. The MRB pulse train from U11017A and the ARB pulse train from U11034D are summed together in NOR gate U11003D, inverted by U11019C and applied to U11018D. The other input to U11018D is the identification and Equalizer pulses from U11017D. The ouput of U11018D is the combiined Reference, Identification and Equalizer pulses. This signal may be monitored at TP11014. The MRB and ARB enable outputs from U11017B and U11017C are also summed together in OR gate U11018A. The output of U11018A is applied to U11021B as the enable signal for the reference priority signal from U11018B. The output of NAND gate U11021B is the reference priority. This output is summed with the identification and equalizer priority signal from U11026B to form the REF/IDENT PRIORITY output at TP11013. This signal is inverted by buffer U11035E and applied to connector J11002 pin 7 as the $\overline{\text{REF/IDENT PRIORITY}}$ signal.

(m) The front panel A/A INTERR switch is sampled by the Computer PC Board, and the information is placed on the data bus. The data bus is applied to octal latch U11052, and is loaded into the octal latch by the active low CS5 signal. This data is the setting of the A/A INTERR thousands and hundreds Thumbwheels. The 10 MHz clock signal is applied to counters U11046B, U11047A and U11047B, where it is divided by 500. The 20 kHz clock signal is applied to rate multipliers U11049 through U11051 pin 9. Octal latches U11052 and U11053 transfer the PRF setting from A/A Interrogation Thumbwheels (21) to the decade rate multipliers U11048 (Most Significant Digit). U11049, U11050 and U11051. The output of the four decade rate multipliers are summed together at U11039B to produce the A/A INTERR signal. The A/A INTERR signal is twice the rate selected by the A/A INTERR Thumbwheels. The 20 kHz clock signal is also applied to the three eight bit shift registers U11065, U11066 and U11067. The three eight bit shift registers plus U11068A, U11068B, U11068C and U11068D make up a pseude-random generator that is summed with the INTERRR signal at U11039A to gate off approximately half of the interrogations. This produces a random PRF approximately equal to the thumbwheel settings.

(n) The output of NAND gate U11039A is applied to multivibrators U11040B and U11040A. The A/A control signal from octal latch U11028 pin 17 is applied to the enable inputs of multivibrators U11040B, U11040A, and U11045B. The X mode signal from octal latch U11028 is applied to the clear input of U11040B and holds U11040B in the cleared state when not in the X mode. Multivibrator U10040B is triggered by the pulse from U11039A if it is enabled by the A/A control signal. Resistor R11008 and capacitor C11006 determine the pulse width of the output of U11040B. The Q output of U11040B is applied to OR gate U11063B. The Y mode signal from octal latch U11028 is applied to the clear input of U11040A and holds U11040B in the cleared state when not in the Y mode. Multivibrator U11040A is triggered by the pulse from U11039A if it is enabled by the A/A control signal. Resistor R11007 and capacitor C11005 determine the pulse width of the output of U11040A . The Q output of U11040A is applied to OR gate U11063B pin 4. The two signals are combined in U11063B and applied to OR gate U11063C pin 9. This signal may be monitored at test piont TP11020. Resistor R11009 and capacitor C11007 determine the pulse width of the output of multivibrator U11045B. The Q outupt of U11045B is applied to OR gate U11063C, and may be monitored at test point TP11021. OR Gate U11063C combines these two signals and applies them to buffer U11035G. Buffer U11035G inverts the signal, and applies it to connector J11002 pin 2 as the A/A INTRR PRIORITY signal.

(o) Priority arbitration between the REF/IDENT PULSE signal at TP11014 and the A/A interrogation pulse train at TP11023 is accomplished by U11041A, U11041B and associated circuitry. The pulses out of multivibrator(s) U11040B are applied to NAND gate U11038D. These pulses are combined in U11038D and applied to the clock input of flip-flop U11041A. The D input of U11041A is the REF/IDENT PRIORITY signal from NAND gate U11021A. If the REF/IDENT PRIORITY signal is low, then the clock signal from U11038D clocks a low to the output of U11041A which may be monitored at test point TP11024. The clock input of U11041B is the REF/IDENT PULSE signal from OR gate U11018D. Since this signal always has the highest priority, a low is clocked to the Q output of U11041B. The output(s) of U11041B and U11041A are combined in NAND gate U11037C. The falling edge of the pulses occur when P2 is generated in X modes or immediately following P1 in Y modes. The output of U11037C is a pulse train which may contain reference bursts, identification pulses, and A/A interrogation pulses. The rising edge of these pulses triggers P1 of the desired pulse train. This signal may be monitored at test point TP11015.

(p) The data bus is applied to octal latch U11054, and is loaded into the latch by the CS6 signal. The output of octal latch U11054 is applied to counters U11060 and U11061. This data is the 0.1 microsecond and 1.0 microsecond P1 to P2 pulse spacing data. The data bus is loaded into octal latch U11055 by the CS7 signal. The output of octal latch U11055 is applied to counter U11062. This data is the 10.0 microsecond P1 to P2 pulse spacing data. The 10 MHz clock signal from buffer U11002A is the clock for counters U11060, U11061 and U11062. The output of flip-flop U11043B is the load signal for counters U11060, U11061, and U11062. The output of counter U11060 is inverted by NAND gate U11037D and is applied to counter U11061 as an inhibit signal for counter U11061. The output of counter U11060 is also applied to NAND gate U11037B along with the output of counter U11061. The output of U11037B is an inhibit signal for counter U11062. The output of counter U11062 is combined with the pulse train from U11037C in NAND gate U11037A. This signal is applied to the D input of flip-flop U11043B. Flip-flop U11043B is clocked by the 10 MHz clock signal. As a result of a high output from U11037C, the output from flip-flop U11043B to counter U11060, U11061 and U11062 is clocked high. This high output releases the load input to counters U11060, U11061 and U11062 and allows them to begin counting. At the end of count, the terminal count output of U11062 forces a low to be clocked to the output of U11043B which causes the counters to be held in the load state. The Q output of flip-flop U11043B is applied to multivibrator U11042B. The pulse width of the

output of U11042B is determined by capacitor C11009 and resistor R11011. The Q output of U11042B is the P1 pulse output. It is applied to NAND gate U11036D and flip-flop U11059A. The output of flip-flop U11059A is the P2 GATE pulse and is applied to OR Gate U11063D. The P2 GATE pulse may be monitored at test point TP11018. U11059A must receive a pulse on J11002 pin 8 to enable the generation of P2 when A/A interrogation pulses are being generated. The Q output of flip-flop U11043A is applied to multivibrator U11042A. The pulse width of the output of U11042A is determined by capacitor C11008 and resistor R11010. The $\overline{Q}$ output of U11042A is clocked by the PULSE IN signal at connedctor J11002.

(q) U11059B, U11036D, U11036B, U11034A and associated circuitry steer the P1 and P2 pulses to either the $\overline{\text{REF/IDENT PULSE}}$ output or A/A INTERR PULSE output at P11002. The P1 and P2 pulses are combined in NAND gate U11036D. The output of U11036D is the P1 and P2 pulses, and it may be monitored at test point TP11019. The P1 and P2 pulses are combined with the pulse steering signal from flip-flop U11059B in NAND gate U11036B. The resultant signal is OR'd by U11069B with ENABLE signal from U11070A and inverted by buffer U11035F and applied to connnector J11002 as the A/A INTERR pulse signal. The P1 and P2 pulses are combined with the Q counter of flip-flop U11059B in AND gate U11034A. REF IDENT pulses are inverted and gated ON or OFF by U11070D. This signal is then inverted again by U11070B and again by buffer U11035H and applied to connector J11002 as the $\overline{\text{REF/IDENT PULSE}}$.

(r) When J100110 ENABLE is active, U11070D gates off all REF/IDENT pulses, U11069B gatres off all A/A INTERR pulses, and U11069D allows TRIGGER input (J10011) to have priority. $\overline{\text{ENABLE}}$ signal is inverted by U11070A and OR'd with interenal $\overline{\text{REF/IDENT PRIORITY}}$, then inverted by U11035E to produce $\overline{\text{REF/IDENT PRIORITY}}$ signal. When enabled by J10010 (ENABLE). $\overline{\text{TRIGGER}}$ input (J10011) is gated by U11069D, U11070B and inverted by U11035H to produce $\overline{\text{REF/IDENT PULSE OUT}}$.

(s) Programmable Logic device U11071 contains the lower two counter digits of the reply delay counter, the counter control circuits, and address decoding circuits for octal latches U11072 and U11073. U11074 counts the 10 μs digit of the reply delay measurement. The $\overline{\text{START}}$ signal, produced by U11044B, is triggered on the rising edge of P1 and is adjustable to allow for modulator and video delays. The $\overline{\text{START}}$ signal is used to reset and reply delay counters to zero and begin the count. The count can be latched into U11072 and U11073 by either the receipt of a video pulse, or upon the counters reaching a max count of 90.0 μs. After the count is latched in, it can be read by the Computer PC Board and will remain unchanged until a new value is latched in.

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3. PC Boards and Schematics

A. General. This subject covers component layout drawings for all PC board assemblies, interconnect diagrams, circuit schematics, waveforms and voltage levels at selected test points, and a troubleshooting table. The drawings are in essentially the same order as they are discussed in subject 1, theory of operation.

B. How to Use Schematics. There is one schematic for each major assembly. To trace from one assembly to another, see the appropriate interconnect diagram, find the connector and cable that carries the signal. This can be done by finding the connector reference designation on the interconnect diagram that is identical to that on the schematic. Trace the interconnecting cable to the destination (assembly) and from there to the signal receiving or transmitting circuit.

C. Alphabetical Index of Interconnect Diagrams and Circuit Schematics.

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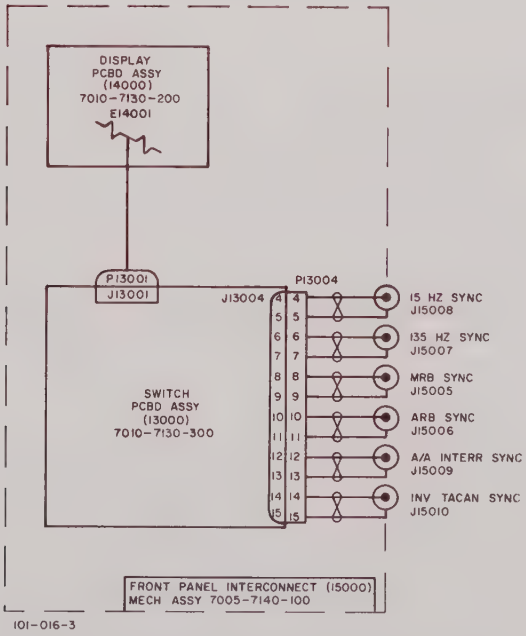
D. Troubleshooting to Module Level. Table 1 is to be used as a guide to fault isolation to the module level.

SYMPTOM	CAUSE	REMEDY
1. Composite output malfunction	a. Fault on Analog PC Board	Troubleshoot Analog PC Board
2. 15 Hz output malfunction	a. Fault on Analog PC Board	Troubleshoot Analog PC Board
3. 135 Hz output malfunction	a. Fault on Analog PC Board	Troubleshoot Analog PC Board
4. Reference pulse malfunction	a. Fault on TACAN PC Board	Troubleshoot TACAN PC Board
5. Identification pulse malfunction	a. Fault on TACAN PC Board	Troubleshoot TACAN PC Board
6. A/A Interrogation pulse malfunction	a. Fault on TACAN PC Board	Troubleshoot TACAN PC Board
7. Deleted		
8. Communication fault between ATC-1400A and T-1401	a. Fault on Computer PC Board	Troubleshoot Computer PC Board
9. Communication fault on RS-232C bus	a. Fault on Computer Board	Troubleshoot Computer PC Board
10. Front panel switches and display not functioning	a. Fault on Switch PC Board	Troubleshoot Switch PC Board
	b. Fault on Computer PC Board	Troubleshoot Computer PC Board
11. Analog and TACAN PC Boards not functioning	a. Fault on Computer PC Board	Troubleshoot Computer PC Board

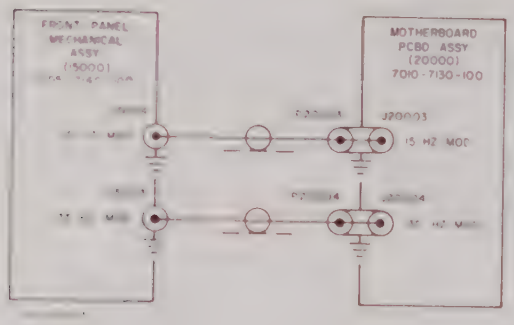
TROUBLESHOOTING TABLE
TABLE 1

SYMPTOM	CAUSE	REMEDY
10. Front panel switches and display not functioning	a. Fault on Switch PC Board	Troubleshoot Switch PC Board
	b. Fault on Computer PC Board	Troubleshoot Computer PC Board
11. Analog and TACAN PC Boards not functioning	a. Fault on Computer PC Board	Troubleshoot Computer PC Board
12. Front panel bearing display malfunction	a. Fault on Front Panel PC Board	Troubleshoot Front Panel PC Board
	b. Fault on Analog PC Board	Troubleshoot Analog PC Board

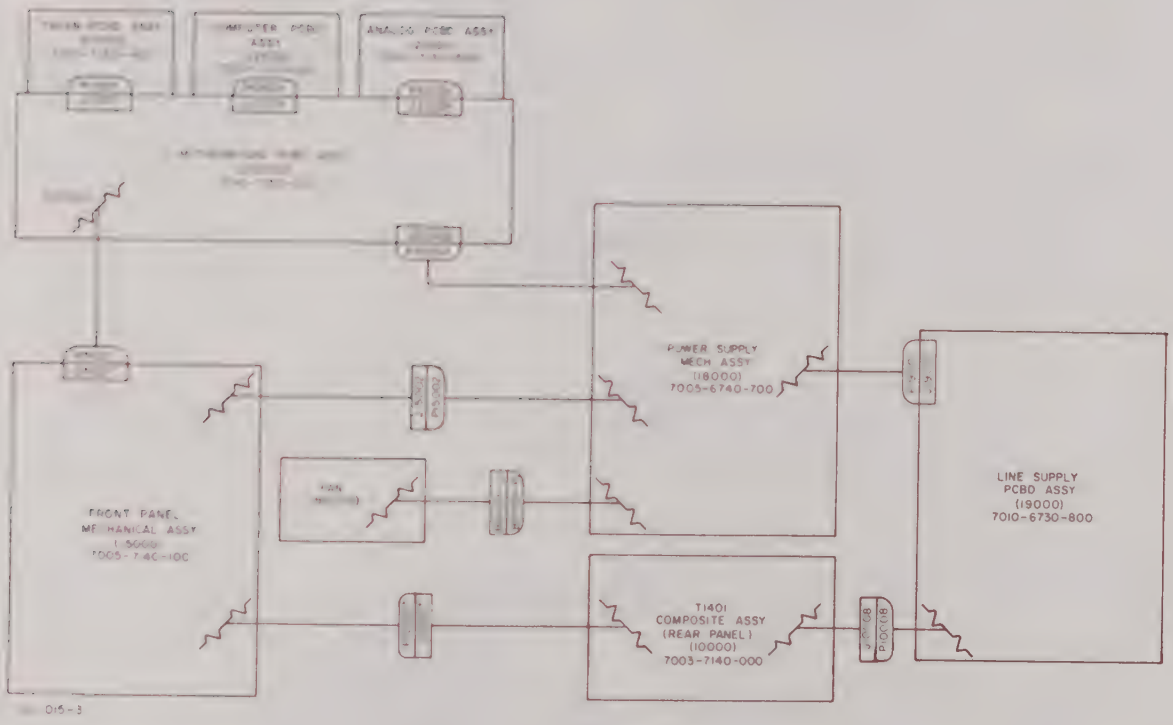
TROUBLESHOOTING TABLE
TABLE 1



Front Panel, Interconnect Diagram
Figure 8



Coaxial Cable, Interconnect Diagram
Figure 9



Interconnect Diagram
Figure 10

CUSTOMER RECOMMENDED CHANGES TO TECHNICAL MANUALS

CUSTOMER INFORMATION

NAME (PLEASE PRINT) _____ DATE _____

YOUR TITLE _____ BUSINESS PHONE # _____

COMPANY NAME _____

BUSINESS ADDRESS _____

CITY _____ STATE _____ ZIP _____

PRODUCT INFORMATION

MODEL # _____ SERIAL # _____

MANUAL TYPE

- ☐ OPERATOR'S GUIDE
- ☐ OPERATION MANUAL
- ☐ MAINTENANCE MANUAL
- ☐ ILLUSTRATED PARTS CAT.

PUBLICATION DATE _____

PLEASE BE SPECIFIC IN IDENTIFYING PROBLEMS

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